# The Standard Physiology.

THE

# STANDARD PHYSIOLOGY

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WITH NOTES ON

*ANATOMY AND HYGIENE; AID TO THE INJURED; DISINFECTANTS, ETC.*

ALSO CONTAINING

EXPLANATORY INDEX TO THE "STANDARD" MANIKIN.

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# THE STANDARD PHYSIOLOGY.

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## *ANATOMY, PHYSIOLOGY, AND HYGIENE.*

**What to Study.** To thoroughly understand the human body so that we may care for it in health, as well as in sickness, it is necessary to study its construction, the functions of the various parts, and the laws which govern health.

The subject for study is divided into three parts, which are defined as follows:

*Anatomy* treats of the construction and relations of the different parts of the body.

*Physiology* treats of the functions of the various parts of the body.

*Hygiene* treats of the preservation of health.

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## *BONES.*

**Uses.** The framework of the body is composed of about two hundred bones. The number varying at

different periods of life. 1. They preserve the shape of the body; 2. Protect the delicate organs, as the bones of the skull and chest; and 3. Serve for attachment of muscles, so that they may act as levers to produce motion.

**Forms.** Bones differ in form according to their uses. For the arms and legs, some are long; for strength, some are short and thick; for covering a cavity, some are flat; while for special use, some are irregular. Their general form is such as to combine strength and lightness.

**Composition.** The bones are made up of animal matter to give strength and elasticity, and mineral matter to give hardness and rigidness. In youth, the proportions are about half and half, while in the adult they consist of one-third animal and two-thirds mineral.

**Experiment.** Soak a bone in a dilute solution of hydrochloric acid for several days. The acid will remove the mineral matter, and the bone, while not losing its shape, will become flexible, and can be tied into a knot. Take another bone and place it in the fire; the animal part will be burned out and the mineral remains. The shape will not be changed, but the pure-white remains may be crumbled between the fingers.

**Ossification.** All bones are at first composed of Cartilage. Mineral matter is deposited in this tissue, and the substance is said to have *ossified*, or turned *to* bone. The greater the proportion of animal matter in a bone, the quicker a broken bone will mend. Therefore, children's bones, when broken, will heal more easily than those of elderly people.

**Growth of the Bones.** The bones are filled with a spongy substance filled with canals, which serve as pas-

sages for blood-vessels that nourish the bones. The whole structure is constantly changing, old material being taken out and new supplied in its place.

**Experiment.** Take two rabbits, and feed one of them on food mixed with madder for three weeks. Upon killing the rabbits, the bones will be different. The bones of the one fed on madder will be tinged with red.

**Periosteum.** Surrounding the bone is a vascular membrane called the *periosteum.* It enables the blood-vessels to reach all parts of the bone, and forms a medium of attachment for tendons. It also contains many bone-forming cells, and will, if not destroyed, cause new bone to grow.

**Endosteum.** Within the bone are cavities, which are lined with a membrane quite similar to the periosteum, called the *endosteum.* This contains numerous bone-forming cells, and is very active in case of a broken bone.

**Marrow.** Within, all long bones there is a long hollow tube which contains a substance called *medulla or marrow.* This consists of about 95 per cent fat.

**Sesamoid Bones.** Small bones are found at the roots of the thumbs and great toes. These are absent in people who work but little, but are found to be of considerable size in people who labor. They are sometimes present in the hands or in the feet only according to the kind of work done. These are called *sesamoid bones.*

**Fractures.** A breaking or solution of continuity in a bone is called a fracture.

*Simple Fracture.* When a bone is broken into two fragments, but does not extend through the skin, it is called a *simple fracture.*

*Compound Fracture.* When the bone is exposed to or communicates with the air, by a wound of the soft parts, it is called a *compound fracture.*

*Repair of the Bone.* Nature begins soon after the breaking of a bone to repair. Blood slowly flows out of the ends of the severed parts, and a substance known as *callus* is formed around and between the ends of the broken bone. Although this substance is soft at first, it gradually hardens, and at the end of about six weeks the bones are quite firmly united. This substance becomes in about one year similar to bone.

**Dislocation.** Bones, sometimes by accident are displaced. The tissues which hold them in position are often torn, and inflammation soon supervenes. A dislocation should be reduced as soon as possible.

**Sprains.** When the ligaments which bind the bones together are strained, twisted, or torn from their attachments, it is called a *sprain.* They are quite as serious as a broken bone, and require careful attention. By using a sprained limb too soon, it may be permanently injured. A long rest should be given a sprained joint.

# TABLE OF THE BONES.

- **I. THE HEAD.** (*28 bones.*)
  - 1. CRANIUM (*8 bones.*)
    - Frontal Bone (forehead).
    - Two Parietal Bones.
    - Two Temporal (temple) Bones.
    - Sphenoid Bone.
    - Ethmoid (sieve-like bone at root of nose).
    - Occipital Bone (back and base of skull).
  - 2. FACE (*14 bones.*)
    - Two Superior Maxillary (upper jaw) Bone.
    - Inferior Maxillary (lower jaw) Bones.
    - Two Malar (cheek) Bones.
    - Two Lachrymal Bones.
    - Two Turbinated (scroll-like) Bones, each side of nose.
    - Two Nasal Bones (bridge of nose).
    - Vomer (the bone between the nostrils).
    - Two Palate Bones.
  - 3. EARS (6 bones.)
    - Hammer.
    - Anvil.
    - Stirrup.
- **II. THE TRUNK.** (*54 bones.*)
  - 1. SPINAL COLUMN.
    - Cervical Vertebræ (seven).
    - Dorsal Vertebræ (twelve).
    - Lumbar Vertebræ (five).
  - 2. RIBS
    - True Ribs.
    - False Ribs.
  - 3. STERNUM (breast bone).
  - 4. OS HYOIDES (bone at the root of tongue).
  - 5. PELVIS
    - Two Innominata.
    - Sacrum.
    - Coccyx.
- **III. THE LIMBS.** (*124 bones.*)
  - 1. UPPER LIMBS (*64 bones.*)
    - Shoulder
      - *Clavicle.*
      - *Scapula.*
    - Arm
      - *Humerus.*
      - *Ulna and Radius.*
    - Hand
      - *Wrist or Carpal Bones* (*eight*).
      - *Metacarpal Bones* (*five*).
      - *Phalanges* (14 bones.)
  - 2. LOWER LIMBS (*60 bones.*)
    - Leg
      - *Femur.*
      - *Patella.*
      - *Tibia and Fibula.*
    - Foot
      - *Tarsal Bones* (*seven*).
      - *Metatarsal Bones* (*five*).
      - *Phalanges* (14 bones).

For references to Skeleton on Manikin, see Explanatory Index, Plates I. o XII. inclusive.

## JOINTS.

**Classification.** The meeting of two or more bones at a common point or along a common line is called a joint. The joints which allow the surfaces of the bones to move one upon the other are called *movable joints,* while those which do not, are called *immovable joints.*

**Sutures.** Most of the cranial joints are immovable. The ends of the bones are united by ragged edged surfaces, between which are layers of an elastic substance called cartilage. These are called sutures.

**Movable Joints.** The ends of the bones in these joints are covered with a soft, smooth, elastic cartilage and fit perfectly one upon the other. This substance is thickest where the wear is greatest. In addition, the ends of the bones are covered with a thin membrane, which is called *synovial membrane,* because it secretes a fluid not unlike the white of an egg. This fluid lubricates the joints, causes smoothness of motion, and prevents the wear of friction.

**Joints of the Vertebræ.** Between the vertebræ are cushions of cartilage. This not only makes the backbone capable of bending forward, backward, and sideways, but makes the whole column a set of springs, which aids in protecting the brain from sudden jars. If the spine remains bent for a long time in one position, the cartilage becomes compressed on one side, and, soon losing its power to return to its original shape, tends to remain wedge-shaped. In a short time we find

permanent curvature of the spine. This occurs when students are allowed to bend over the desk to bring their eyes nearer their books, instead of lifting their books nearer the eyes. Book-keepers find their right shoulder elevated above the left. Be careful to have pupils keep as nearly an erect posture as possible.

**Subdivision of Movable Joints.** These joints are classified as to the manner of their articulations, as *ball and socket*, *hinge*, and *compound joints*. The shoulder and hip joints are good examples of the first, the knee and elbow of the second, and the wrist of the last. The ball and socket joint gives great freedom of motion, as we know we can move the arm in nearly every direction. The hinge joint allows the bones to open and close as the hinges on a door allows the door to open and close. The compound joint allows many motions, but few of them to any distance.

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## THE TEETH.

**Structure and Use.** Human teeth are bony structures, implanted along the margin of the jaws for the purpose of reducing the food to fragments, thus enabling the digestive fluids to act to best advantage.

**Classes.** Two sets of teeth are developed during life—the first the *temporary* or *milk teeth*, ten in each jaw, viz., four incisors, two canines, and four molars; the second, the *permanent teeth*, sixteen in each jaw, viz.,

four incisors, two canines, four bicuspids, and six molars. The permanent set have the incisors with their chisel-shaped edges formed for cutting, the canines with their sharp edges for cutting and tearing, and the molars for grinding. The last permanent molars, or wisdom teeth, seldom make their appearance before the eighteenth year, and often do not make their appearance till ten years later.

**Parts.** Each tooth consists of

1. *Crown* or *body*, the part projecting above the gum. This is the part exposed to wear, and is protected by a sheath of enamel.

2. *Neck*, the portion between the crown and fang.

3. *Root* or *fang*, the portion imbedded in the socket.

**Structure.** The tooth is composed chiefly of:

1. *Dentine* or *ivory*, which is found in the tooth as the second layer in the crown, and within a thin layer of true bone in the fang. It is easily eaten away by acids formed in the mouth from decaying food. It is covered in the crown by a substance called:

2. *Enamel.* This is the hardest known substance in the body, containing only 3.5 per cent. of animal matter. So long as this substance is not cracked, broken, or destroyed, the teeth will remain healthy.

3. *Pulp.* At the centre of the tooth is a soft, reddish, vascular tissue filling a cavity. This pulp is very sensitive to pain, and irritation causes the tooth-ache.

**Causes of Decay.** Parts of food are often left imbedded between the teeth, and the effect of heat and moisture causes decomposition. In this way a substance is formed which gradually destroys the enamel. The saliva by

evaporation leave a sediment upon the teeth. This is called *tartar*. Matter of various kinds collects in this tartar and a fungus springs up. This also aids in destroying the enamel.

The enamel is often cracked by placing cold substances in the mouth. The enamel suddenly contracts, and the excessive strain causes it to part. Too warm substances will cause the enamel to expand and tend to fold on the surface, which also will cause it to crack.

**Care of the Teeth.** Brush the teeth every morning and evening to remove the sediments of evaporated saliva.

Brush the teeth at least twice a week with some reliable tooth-powder to remove sediment that has been left behind.

Remove particles of food from between the teeth by a quill or wooden tooth-pick. Never use a pin or metal tooth-pick.

If necessary to take medicine containing acid, take it through a glass tube.

Have your teeth examined regularly by a reputable dentist, and have each small *cavity* filled.

Remember that the falling out of the filling from the teeth of young people is not always the dentist's fault. The substance of the teeth in young people is softer than in older persons, and the filling is more liable to drop out. But do not be discouraged; let every cavity be filled and refilled if necessary. The time will come when the substance of the tooth will be hard enough to hold the filling, and a good set of teeth is the result.

In young people the teeth grow, and oftentimes this alone will enlarge the cavity around the hard filling,

allowing it to drop out. Some plastic filling should be used, and the teeth kept filled with it till they stop growing and the substance becomes thoroughly hardened, when it may be removed and gold substituted.

## MUSCLES.

**Structure.** Within the body is a tissue connected with bones, cartilages, ligaments, or skin, which has the power of shortening when irritated mechanically or by nerve force. It is made up into bundles, which consist of fibres running lengthwise of the bundle. Each fibre is made up of small cells arranged like beads on a string. The arrangement of many of these fibres in a bundle gives great strength, while the peculiar arrangement of the cells in each fibre gives great elasticity.

**Attachment.** The ends of the muscles are generally attached to the bone by a strong, flexible, but inelastic substance called *tendons.* The tendons are attached to the periosteum with which it becomes blended, and to the tissue under the skin. Some muscles have more than one tendon at either one end or the other. The *biceps* have two points of attachment at their upper portions. The *triceps* have three. The most fixed point of a muscle is called its *origin,* the point toward which the muscular force is directed is called the *insertion.*

**Ligaments.** This is an elastic tissue, often of a yellowish color. It is useful in joints for holding the bones together, and is used in bands at the wrists and ankles to keep the tendons in place.

**Function.** Muscles are useful in giving form to the body, and to produce movements, which vary according to rapidity and power of their contraction.

**Kinds.** Muscles are classified according to whether their movements are under control of the will-power or not, as: voluntary and involuntary. The *voluntary* are entirely under control of the will-power, and are striped or striated; while the *involuntary* are controled solely by nerve centres, over which the will-power has no direct influence.

**Exception.** The heart, although made up of striated muscle, beats independently of the will.

**Necessity of Exercise.** The effect of exercise upon a muscle is very marked. By proper use the muscle will become hard and compact and will gain in strength, while by disuse the muscle becomes soft, flabby, and weak. Violent exercise will tear down faster than it can be built up, and is very injurious. Moderate exercise is necessary for health. That exercise is best which calls into action as many of the muscles of the body as possible. A system of movements so arranged that they can be used in any school-room is very desirable. Then at certain times of day, after having sat upon the benches for a time, these exercises can be used and the pupils become rested. Violent exercise, such as wrestling, or any other that may cause danger to life or limb, should be carefully prohibited. Riding, walking, rowing, swimming, and innocent out-door games are excellent for exercise.

**A Law of Health.** *"Take moderate exercise daily, but alway stop short of fatigue."*

**Time for Exercise.** Do not exercise much immediately after a meal, unless the exercise be very light. It is sometimes recommended to take a long walk before breakfast. This is suited for strong, healthy people, but is detrimental to the delicate or weak.

**Exercise Immediately after Meals.** This is injurious, because during exercise the blood is taken into the muscles for use. In order that the stomach digestion may begin, the temperature must be raised to one hundred degrees. This is done by an excess of blood flowing around the stomach. If it is called to the muscles, the quantity needed around the stomach will not be supplied and digestion will cease.

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## COMPOSITION OF THE BODY AND THE MOST IMPORTANT SUBSTANCES USED AS FOOD.

**Chemical Basis of Body.** Of the sixty-three elements found in nature, only a very small number are found in any quantity in the body, although traces of many are frequently found. Oxygen, carbon, hydrogen, and nitrogen are found in large quantities in every tissue, making up about 97 per cent. of the whole body. Sulphur, sodium, calcium, chlorine, flourine, silica, iron, and many others are widely distributed, but occur in small quantities. Since the body is composed of these different elements in an established proportion, it is clearly evident that the food should contain these elements in much the same proportions.

**A Typical Food.** Milk and its preparations contain

all the constituents necessary for life and growth, and is a complete typical food. Milk consists of ten parts of *proteids*, ten parts of *fats*, and twenty parts of *sugar*. Eggs are next to milk the most typical food.

**Classes of Food Necessary for Maintenance of Health.** There are five classes of food necessary for maintenance of health, as follows,—1st, the *starches* used for the purpose of adding fat and heat to the body; 2d, the *fats* used for the purpose of maintaining bodily heat; 3d, *ablbuminous* foods used to add force to the system; 4th, *water* used to carry out the many different processes; 5th, *salts* absolutely necessary for the maintenance of health.

Fats are often formed from proteids; this is proved by the fact that the cow does not consume as much fat in a day as she gives in butter.

The body is a most wonderful chemical laboratory, capable of uniting elements from different substances taken into it, forming new substances to be utilized in growth and maintaining health.

**Proteids and Carbohydrates.** The substances taken into the body are classed as *Proteids* and *carbohydrates*. The *Proteids* include all compounds that contain the elements carbon, hydrogen, nitrogen, oxygen, and sulphur. They consist of the albumens, the peptones, the globulins, and fibrin. The *carbohydrates* include the starches, sugars, and fats.

*Proteids.*
- White of egg.
- Casein, the chief part of cheese.
- Lean meat.
- Gluten, the sticky part of dough.

**More Than one Kind of Food Needed.** A person fed on one kind of food would die. Starch, as an example, would not supply any nitrogen to the body, and the person would starve. Some foods contain many elements, and life could be supported by them for a long time. Few foods contain the elements in the right proportion. Lean meat contains most elements, but it would require such a large quantity to supply some of the elements in sufficient quantities that the digestive apparatus would be overtaxed. Nature demands and instinct responds to the call for a mixture of foods. Beans are baked with pork, cheese is taken with maccaroni, rice is boiled with milk, and our bread is spread with butter. Our teeth indicate that a mixed diet should be used, since we have the incisors to cut the vegetables, the canines to tear the flesh, and molars to grind both.

## *METABOLISM.*

The taking of substances derived from the food into the tissues, and the making of them an integral part of their own bodies, together with the breaking down of these tissues and the removal of the results of their destruction, is called *Metabolism.* The first process is called *assimilation*, the second *excretion.*

**The Body a Storehouse.** The body does not merely assimilate sufficient food to replace exactly those particles destroyed, but it does more than this, and acts as a storehouse from which on a sudden requirement nutriment or energy may be derived.

# *DIGESTION.*

**Digestion.** By this we mean the changes which are produced in the food, in order that it may be absorbed into the blood and then be capable of performing various functions.

**Forms of Digestion.** There are three portions of the digestive apparatus in which changes take place in the food, namely; mouth, stomach, and small intestines. The change in the food in the mouth is called *salivary digestion*, that in the stomach *gastric digestion*, that in the small intestines *intestinal digestion*.

**Salivary Digestion.** Situated within the mouth are glands which secrete each day from 7 to 60 ounces of a liquid known as saliva. Its direct digestive function is to convert starch into sugar. It has, however, other functions which may be called mechanical. It aids the mucous glands situated within the mouth to keep the mouth moist, facilitating the mastication of food, the movements of the tongue, and speaking. Another important office is to dissolve solid substances taken into the mouth so that they may be tasted. By mixing with the food dry substances become soft, are easily swallowed, and more easily digested.

**Salivary Glands.** These are six in number, three compound racemose glands on each side. The *parotid*, the largest, lies below and in front of the ear; the *submaxillary* lies below the jaw on the side; and the *sublingual* in front beneath the membrane of the floor of the mouth.

**The Saliva.** This is a mixture of the secretions of the three pairs of salivary glands. It is chiefly water, but contains very small quantities of various substances. It contains a peculiar ferment called *ptyalin*, which has the power of acting upon starch, converting it into sugar.

**Sugar Formed by Action of Saliva.** The sugar formed by the action of saliva upon starch is called *maltose*. It differs from glucose by having one less $H_2O$ in its composition. It finally is further acted upon, and the maltose is changed into *grape sugar* proper.

**Experiment.** Moisten some starch with saliva and place in an air-tight vessel, and let stand over night. Upon examination it will be found to have changed. What is this change, and what has caused it?

**Object of Cooking Starchy Foods.** All starchy foods consist of granules of starch having a cellulose covering. By boiling, this covering is broken and the ferment is thus enabled to act more freely upon the starch.

**Mastication** is the process of making the food fine and mixing it with saliva.

**The Tongue.** The functions of this important organ is to keep the food between the teeth, in which it is assisted by the muscles of the cheeks and lips, to break up soft food by pressing it against the roof of the mouth, to aid in modifying sounds, and by its nerves to aid in taste.

**Gastric Digestion** acts upon the proteids, converting them into peptones. (See "The Stomach," page 19).

**Intestinal Digestion** prepares the fats for assimilation and changes proteids into peptones. (See Small Intestines.)

## *THE STOMACH.*

**Shape, Position, and Size.** The stomach is irregularly conical with a round base turned to the left side. It lies immediately behind the front wall of the abdomen, below the liver and diaphragm, and above the colon. It has two openings: one entering near the heart, called the *cardiac* opening, the other, the one through which the food passes out after stomach digestion, is called the *pylorus*. This opening is on the right side, and is guarded by numerous circular muscular fibres forming a thick ring. This is called the pyloric valve. Since the contents of the stomach passes out on the right side, it is best to recline upon this side, especially if lying down soon after a meal. The stomach will hold about three pints.

**Gastric Juice.** Within the stomach are glands secreting a fluid called gastric juice. It is tolerably clear, straw colored, of acid reaction, sour taste, and has a peculiar characteristic odor. The quantity secreted in twenty-four hours amounts to from ten to fourteen pints. The gastric juice contains, first, *pepsin*, the ferment which dissolves proteids, second, hydrochloric acid, the chief acid found. Lactic acid is also found, but this is due to chemical change. Lactic acid acts upon the proteids in much the same manner as does hydrochloric acid. It is the milk-curdling ferment.

**Pepsin.** Most physiologists claim that pepsin does not exist in the glands ready formed, but that it is due

to the presence of a compound, which forms pepsin as soon as it comes in contact with the acid in the stomach. This fact is known that it does not act only in acidulated liquids. Pepsin during its action does not suffer any change, it acts simply by catalysis. A portion of the pepsin is destroyed.

**Chyme.** The mixture of food and gastric juice is known as *chyme.* As it passes out of the stomach it is of a grayish color, and consists of starch partially acted upon by the saliva, cane-sugar which has been slowly changed by the gastric juice into glucose, the dissolved albumens, fats broken up by their albuminous sacs having been dissolved, and a quantity of gastric juice.

**Action and Absorption.** After the food enters the stomach it is acted upon by the gastric juice, and is kept in continual movement by the action of the muscular coat. The rotary movement toward the pylorus continues as long as any food remains in the stomach. This is called the *Peristaltic movement.* The changes which the food undergoes are partly mechanical and partly chemical.

A portion of the food digested in the stomach, together with indigestible liquids, are immediately absorbed into the blood. It is then carried to the heart and sent on its usual course through the lungs. Alcohol is absorbed in this way to quite an extent. This accounts for its odor being in the breath so soon after drinking. Nature tries to throw off in every way this injurious and indigestible substance.

## *THE LIVER.*

**Description.** The liver is the largest gland in the body; in an adult man it weighs from three to four pounds. It is located on the right side, below the diaphragm. It differs from other glands in its chief supply of blood being venous. All the blood from the spleen, the stomach, and the intestines passes through the liver before it reaches the general circulation. The blood-vessels are derived from two sources: first, the venous, which enters by means of the *vena porta*, and the second, the arterial, which are branches of the *hepatic artery*.

**Functions.** The functions of the liver are three: the secrection of bile, the formation of glycogen, and the destruction of worn out blood cells.

**Bile.** The bile is a true secretion, being produced by the cells of the glands. It is a yellowish-brown or dark green transparent fluid with a very bitter taste. The secretion consisting of bile acids is carried to a small pear-shaped receptacle called the gall-bladder. This bladder, some three or four inches long, and capable of holding about ten fluid drachms, lies in a fissure on the under surface of the liver. The secretion which came from the liver is here mixed with a mucus which makes it viscid. This mucus is secreted by the wall of the gall-bladder. The quantity of bile secreted each day is estimated to be about seventeen ounces. The bile is emptied into the duodenum where it aids in digestion.

**Functions of the Bile.** The bile has the power of breaking up or emulsifying the fats. It lubricates the walls of the intestines, and it increases the osmotic power of the wall of the intestines in order that the fats may be more easily absorbed.

**Glycogen.** The use of this substance in the body is not really known. It is an animal starch, and is changed into sugar by a ferment. It is probably derived from the carbohydrates of the food. It is closely allied to starch, and readily convertible by fermentation into grape-sugar and alcohol. It is not, however, converted into grape-sugar in the healthy human body, although it is possible that it is converted into sugar in disease. It is probably either converted into fat or oxidized for the production of heat or work.

The liver must be considered as an excretory organ as well as an organ secreting a useful product. By secreting the bile, it removes poisons from the blood. Should the liver fail to perform this office, the poison is left in the blood, and *jaundice* is the result. If the liver cannot be excited to action, the person dies with symptoms of poison.

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## PANCREAS AND SPLEEN.

Back of the stomach lies a large racemose gland known as the *pancreas.* This gland furnishes a thick, transparent, odorless, saltish juice which is brought into the duodenum. This contains at least four ferments, and is a powerful and important digestive fluid. A large portion of the starch of the food is unchanged by the saliva; this passes into the duodenum and is dissolved

by the pancreatic secretion. The residue of the albumen left undigested in the stomach is also acted upon by this digestive secretion as well as the fats of the food which are dissolved and changed into fatty acids and glycerine. These fatty acids unite with a portion of the secretion and form a soapy liquid. The chyme which came from the stomach has become emulsified, changing into a white, opaque liquid called chyle.

**Spleen.** The soft, brittle, very vascular, oblong, ductless organ embracing the cardiac end of the stomach is called the spleen. The functions are uncertain. Sir J. Paget called the spleen the graveyard of the red, and the birthplace of the white, blood corpuscles. It is probable that the former undergo disintegration, and the latter are developed in the spleen. The spleen becomes considerably enlarged after the digestion of a full meal, and it is probable that the nitrogenous products undergo considerable modification in the spleen.

## *THE INTESTINES AND LYMPHATIC SYSTEM.*

**The Intestines.** The length of the intestines is about twenty-five feet. They are divided into two classes, the small, some twenty feet long, and the large, about five feet long. The small intestine has three divisions, the *duodenum*, the *jejunum* and the *illeum*.

**The Duodenum,** as long as the breadth of twelve fingers, *i.e.*, eight to ten inches, is the part which receives the food as it passes from the stomach through the pylorus. Into this pass obliquely the common bile and pancreatic ducts. The mucous membrane lining the small intestine contains glands which secrete a yellow, strongly

alkaline fluid called the *intestinal fluid.* This secretion probably assists in the solution of the albumens of the food.

**Jejunum,** so called because usually empty after death, includes about nine feet of the small intestine.

**Illeum** includes the remainder of the small intestine. This opens into the commencement of the large intestine, the orifice being guarded by a two-leaved valve.

**Absorption.** The function of the small intestine is to hold the food for the completion of digestion, and to absorb from the digested food, called *chyle,* the nutritious part. To carry on the process of absorption the wall of the intestine is furnished with small processes called *villi,* containing blood-vessels and lacteals. Each villus contains blood-capillaries which absorb sugars and proteids, and a lacteal which absorbs the fats. The greater part of the absorption is carried on in the upper half of the small intestine.

**Portal Circulation.** The sugars and proteids which have been absorbed into the blood in the capillaries of the villi are carried by the veins into the large vein called the portal vein. This blood, after passing through the liver and having bile taken from it, and changed in other respects not well understood, finds its way upward by the *hepatic vein,* and is emptied into the vena cava, which in turn pours it into the heart.

**The Lymphatics and Lacteals.** That portion of the food taken up by the lacteals has a milk-like appearance, hence the name. The lacteals unite and finally form lymphatic network, which end in a sac-like receptacle, called the *receptaculum chyli.* At this point is met the lymphatics of the lower extremities. The

*chyle receptacle* opens into the *thoracic duct,* which is about the size of a goose-quill, and extends upward in front of the spinal column and behind the esophagus. At the upper end of this duct there is a crook, much resembling the bended part of a shepherd's crook, which turns forward and downward, emptying into the junction of the left jugular and the left subclavian vein.

Thus we see that the different classes of nutrition, although travelling by different routes, find themselves mingling with each other and with the impure blood, which, after passing through the right side of the heart, then through the lungs, then back to the left side of the heart, is sent coursing through the body, where the nutrition is deposited, or where some product is separated from the blood.

**The Large Intestine** receives through the two-leaved valves opening into it the remainder of the liquid from which the absorbents of the small intestine has extracted the nutrition.

**Function.** The main function of the large intestine is to absorb the liquids from the matter coming from the small intestine.

**Divisions.** The main divisions of the large intestine are the ascending colon, the transverse colon, the descending colon, and the rectum.

**Appendix Vermiformis.** Springing from the head or beginning of the colon is a narrow, blind-ended worm-like tube, from three to six inches long. Its function is not known. Grape and other seeds occasionally enter the opening, cause inflammation and oftentimes death.

When the waste matter remains too long in the large intestine nearly all the moisture, as well as poisonous

matter, is absorbed into the system, giving rise to unpleasant conditions. This state should be carefully avoided by means of exercise, drinking quantities of water on empty stomachs especially early in morning, plenty of exercise in open air, and laxative foods.

**Secretion and Excretion.** Various glands and membranes of the body directly or indirectly separate from the blood, by a process peculiar to a gland or membrane, some product. This product is called an *excretion* when it is passed out of the body as waste, and a secretion when it carries on some function in the body. The following are examples of each kind.

| | |
|---|---|
| EXCRETING GLANDS. | Kidney—*Urea.*<br>*Liver—*Bile.*<br>*Sweat glands—*Watery liquid.* |
| SECRETING GLANDS. | Salivary glands—*Saliva.*<br>Stomach—*Gastric juice.* { *Pepsin.* *Hydrochloric acid.*<br>*Liver—*Bile.*<br>Pancreas—*Pancreatic juice.*<br>Small Intestine—*Intestinal juice.*<br>Pericardium—*Lubricating liquid.*<br>Lacrymal glands—*Tears.*<br>*Sweat glands—*Watery liquid.*<br>Sebaceous glands—*Oily matter.*<br>Pleura—*Lubricating fluid.*<br>Synovial sac—*Egg-like fluid.*<br>Modified sweat glands—*Ear-wax* |

Each of these glands and its excretions or secretions is described under its appropriate head.

Secretions differ in character. Some are mere filtrations of substances already found in the blood, as for examples, tears and perspiration, while others are known

* These glands act both as excreting and secreting glands.

as true secretions, being produced by the cells of the glands, viz.: bile, pancreatine, etc.

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## THE BLOOD.

**Function and Description.** The blood serves in the distribution of nutritious materials, and collects the substances, which have resulted from the changes constantly going on, and carries them to the excretory organs. It also acts as a regulator of temperature, and keeps up a constant intercourse between the tissues and the air, supplying them with oxygen and giving off the carbonic-dioxide which it carries to the lungs. Blood consists of a pale straw-colored fluid, the *plasma* in which float a vast number of red and white disk-like bodies known as *corpuscles*.

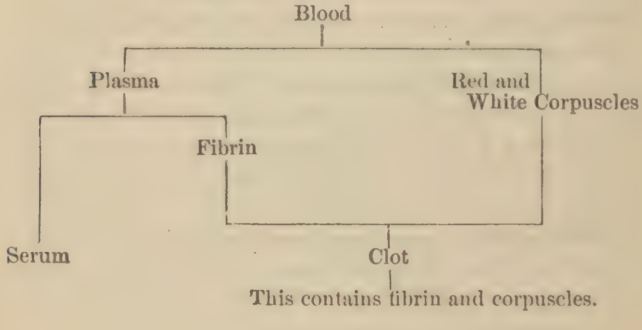
**Color of the Blood.** As the blood is found in the blood-vessels leading from the heart to all parts of the body, except to the lungs, it is of a bright scarlet-red, while the blood going to the heart, except that from the lungs, is of a dark-bluish color. The blood of a bright scarlet-red color contains more oxygen and less carbonic-dioxide than the dark-blue blood. The scarlet-red blood carries the oxygen to the capillaries, where it is taken up by the tissues, and, uniting with the carbon found in them, forms a new gas called carbonic-dioxide. This chemical union forms heat, hence the blood leaving the capillaries is warmer than the blood which enters them. The loss of the oxygen and the addition of the new gas, together with other waste matter, has caused the color to change from its bright scarlet-red to the dark blue.

**Red and White Corpuscles.** The corpuscles give the color to the blood. Because the red ones are greatly in excess is the reason for the color of the blood. The red corpuscles carry oxygen and nutrition to the various parts of the body, but the use of the white ones is not clearly understood.

**Quantity of Blood.** The blood makes up from one-tenth to one-thirteenth part of the weight of the body.

**Coagulation.** When blood is drawn from the body it is perfectly fluid, but becomes thick, forming a clot having the appearance of a solid mass of gelatine. This clotting is due to the presence of a substance called fibrin, which becomes solid. This fibrin forms into a net, which entangles the corpuscles and forms a blood-clot. The fibrin is a part of the plasma, which has separated into two parts fibrin and serum. The *serum* is a yellowish transparent fluid. It is of an adhesive nature, and when the body is cut, it is given off by the blood and aids in holding the severed parts together.

Blood when coagulated is as follows:



# THE HEART.

The heart of an adult weighs about nine ounces, and is about the size of the closed hand. The heart is a hollow muscle having four cavities. It is divided so that the cavities on the right side have no communication with those on the left, but the two cavities on either side are connected by valves. The upper cavities are called *auricles* from their supposed resemblance to a dog's ear. The one on the upper right side is called the right auricle, the one on the left the left auricle. The cavities at the lower part of the heart are called ventricles, taking the names right ventricle and left ventricle according to location. The heart is conical in shape, having its apex downward and toward the left side.

**Action of Heart.** The right side of the heart receives the dark blue blood from the *vena cava.* It is received into the right auricle, where it passes through the *tricuspid* valve into the right ventricle. It is there forced out into the lungs through the pulmonary artery. The blood here gives up its *carbonic-dioxide,* takes on *oxygen,* and returns to the left auricle, through the pulmonary vein. The blood, now of a bright scarlet hue, passes through the *bicuspid valves* into the left ventricle, from which it is forced out through the aorta into the arteries, by which it is distributed over all parts of the body.

**Power of Heart.** The heart sends out from each ventricle at each beat from four to six ounces of blood, with

a force sufficient to lift three pounds one foot. Of this work the left ventricle does about three-fourths. The heart in a single day exerts enough force to lift one ton over one hundred twenty feet.

**Movements of the Heart.** When the heart closes to force out the blood, the movement is called *systole*, and when expanding, *diastole*. There is a pause following each expansion. Hence the heart takes a rest after each beat. This amounts to several hours per day.

**Pericardium.** Surrounding the heart is a protecting membrane called the *pericardium*. This consists of two layers which secrete a quantity of liquid for lubricating their surfaces as they move one upon the other.

**Functions of Blood-vessels.** The blood-vessels carry blood to and from the various parts of the body. They are divided into three classes: *the arteries and arterioles*, carrying blood from the heart; *the capillaries*, bringing the blood into close relation with the tissues; and the *veins*, carrying the blood back to the heart.

**Arteries.** These are hollow tubes carrying blood to the capillaries, which are situated in all parts of the body. The arteries contain no valves, but consist of three layers. The inside one forms a smooth surface for the blood to pass over, the outside one an elastic layer, while between them is a muscular layer which regulates the amount of blood received by each part. This coat is necessary, as it is manifest that the heart cannot regulate the supply of blood sent to each portion of the body.

**Capillaries.** The capillaries not only carry blood, but, owing to the construction of their walls, they enable the blood to come in intimate relations with the tissues.

By the blood thus coming so intimately connected with the tissue, it is enabled to deposit nourishment, give up its oxygen, and take in return what has been chemically united. They take from the blood the nourishment, and give it off as a fluid known as *lymph,* whose function is to irrigate and nourish.

**Veins.** In most veins are valves which flap back against the side as the blood flows onward toward the heart. Thus the blood cannot be forced backward by any cause. The walls of veins are not so thick, strong, or elastic as are those of the arteries—the strength and elasticity not being needed, as the blood simply flows through the veins and is not forced through as it is in the arteries. The blood is aided in its course through the veins by a contraction of the voluntary muscles, indirect action of the valves in the veins, and by suction produced by the movements of the thorax in breathing.

**Pulse.** At certain portions of the body arteries come near the surface. If the finger be placed over these blood-vessels a beating can be felt. These beats are caused by the heart forcing the blood into the arteries. Each pulse represents a heart beat.

## RESPIRATION.

**The Respiratory Apparatus.** This consists of the lungs, bronchial tubes, trachea and larynx. The lungs are surrounded by a double membrane called the *Pleura.* One layer is attached to the lungs, the other to the chest wall. This membrane secretes a fluid to lubricate their surfaces as they move one upon another.

**Lungs.** The lungs consist of two parts separated by the heart and its openings. They are divided into lobes, the right lung having three, the left lung only two. The lungs weigh about forty-two ounces, the right one being about two ounces heavier than the left.

**Trachea.** The membranous, cylindrical air-tube, extending downward from the larynx to opposite the fourth or fifth dorsal vertebra, is called the *Trachea.*

**Larynx.** (See page 43.)

**Bronchial Tubes.** The trachea divides into two parts forming *the right and the left bronchus.* These extend into the lungs, dividing and subdividing to form the *bronchial tubes.* At the termination of each tube there is found an air cell, in which are small recesses measuring from one two-hundredths to one-seventieth of an inch in diameter. These are separated from each other by a delicate membrane, between the layers of which lies the plexus formed by the pulmonary artery. The blood is thus exposed to the air on two surfaces.

**Osmose.** There is a law of nature, in accordance with which gases, if separated by a thin membrane, will rapidly pass through and mix with considerable force. This phenomenon is called *osmose.* It is in obedience to this law that the carbonic-dioxide of the blood passes outward through the membrane into the air, and the oxygen of the air passes inward through the membrane and mixes with the blood.

**From Blue to Red.** The color of the blood is here changed. As it loses the carbonic-dioxide and takes on oxygen the color changes from the dark blue to the bright scarlet. The blood also gives off into the air

other effete products which have been held in the blood in the form of gases.

**Breathing.** The taking or drawing in of the air into the lungs is called inspiration. The side walls and front, of the chest move upward and outward, forming a vacuum and the air rushes in to fill the cavity. The sending of the air out of the lungs is called expiration. This is ordinarily accomplished by the weight of the chest, which sinks down, displacing the air.

**Changes in the Air caused by Respiration.**

1. Expired air warmer than inspired air.
2. Expired air contains more carbonic-dioxide.
3. Expired air contains more effete matter.
4. Expired air contains large quantities of watery vapor.
5. Inspired air contains more oxygen than expired air.

**Capacity of the Lungs.** The amount of air that can be forced out of the lungs after a forced inspiration is called the *vital capacity.*

**Tidal Air.** We do not usually breathe into our lungs all the air that they will contain. Nor do we usually force out all the air we possibly can. The amount of air ordinarily taken in at each respiration is about thirty cubic inches. This is called *tidal air.*

**Complemental Air.** The amount of air that can be taken in after an ordinary inspiration is called *complemental air.*

**Reserve Air.** The amount of air that can be voluntarily forced out after ordinary expiration is called *reserve air.* It amounts to about one hundred cubic inches.

**Residual Air.** There remains within our lungs about

one hundred twenty cubic inches which cannot be forced out. This is known as *residual air*.

**Amount of Carbonic-Dioxide Exhaled.** While this is influenced by many conditions the average amount given off by a man in an hour equals 1346 cubic inches.

**Amount of Oxygen used.** Of the oxygen taken into the lungs about 4½ per cent is abstracted.

**Experiment.** Consider the amount of oxygen in a cubic foot of air at 20 per cent. The amount of this used in each breath is 4½ per cent. of the amount of oxygen breathed into the lungs. The number of inspirations is 16 per minute, and the amount of air breathed each inspiration as 30 cubic inches. Take into account the size of your school-room, the number of occupants, and find how long it will take to use all the oxygen in your room.

**Second Experiment.** Consider the above, and add to your calculation that each person gives off 1346 cubic inches of carbonic-dioxide and see how long before the air in the room will contain 50 per cent of this gas.

By use of these examples show the need of ventilation.

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## *ANIMAL HEAT.*

**Temperature of the Body.** The temperature at which the body of a warm blooded animal is maintained is known as *animal heat*. The normal temperature of man is ninety-eight and five-eighths degrees F.

**Change in Temperature.** While temperature in health varies only a fraction of a degree, yet age, sex, time of

day, exercise, climate, food, and drink all have an influence upon it. In disease, temperature varies greatly. In Asiatic cholera it often falls as low as 80 degrees, while in fever it may rise as high as 106, or even 110 degrees.

**Source of Animal Heat.** Heat is obtained from the food taken into the body and from the oxygen taken in during respiration. The blood, during digestion, becomes loaded with more carbon, hydrogen, and oxygen, than is needed for the repair of the tissues, and these gases uniting with the sulphates develop heat by chemical means very rapidly. The oxygen in the blood which is taken in during respiration is carried to the various parts of the body, where in the capillaries it unites with the carbon of the tissues forming carbonic-dioxide. This is given off into the air from the lungs. Blood which leaves the capillaries is much warmer than the blood received into them.

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## THE KIDNEYS.

**Description.** The kidneys are two bean-shaped glands, a little more than half the size of the closed fist, and weighing about five ounces. The left kidney is usually a little heavier than the right. They are located in the lumbar region, one on each side of the back-bone, each kidney reaching from the eleventh rib down to the crest of the iliac, but the right a little lower down than the left. The kidneys are embedded in a mass of fat behind the peritoneum, which with the aid of their blood vessels retains them in place.

**Function.** The work of the kidneys is to separate from the blood the substance by which the nitrogen of decomposed tissue is given off. This substance is called *urea.* The quantity of *solid* excreted by the kidneys in the twenty-four hours varies from two to three ounces, about half of which consists of urea. Urea is a poisonous matter, and if not removed from the blood will necessarily accumulate and cause disease. This secretion, unlike most others, cannot be utilized either in digestion or in any other process, hence must be removed from the system. The kidneys are sometimes called the "**exclusively excretory organs.**"

**Action.** The arteries which carry the blood to the kidneys are called *renal* arteries, and the veins which carry the blood from the kidneys to the large veins leading to the heart are called *renal* veins. The kidneys do not act constantly but alternate in their action. The blood passes into the kidneys through the arteries, it then reaches the capillaries of the kidneys which have the power of removing the watery part of the blood containing urea. The blood is then taken up by the small veins and carried to the renal veins.

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## THE SKIN.

**Description.** The skin consists of a layer of vascular tissue called the *dermis*, *cutis-vera*, or *true skin*, covered by a layer of a horny-like substance which has neither nerves nor blood vessels, called the *epidermis*, or *cuticle.* Underneath and within the true skin are several organs

with special functions, as follows: the sweat glands, the sebaceous glands and the hair follicles. The surface of the true skin is covered with minute *papillæ* which contain nerves, rendering the surface very sensitive.

**General Functions of the Skin.** It acts as a protection of the deeper portions of the body, it contains excretory and absorbing organs, it affords surface for the spreading out of the nerves of feeling, and acts an important part in regulating the temperature of the body.

**Special Function of the Cuticle.** It protects the papillæ and forms a check upon evaporation from the skin.

**Sweat Glands.** These glands pour out the moisture on the surface of the body, through spiral tubes which become straight as they approach the surface.

**Difference Between Sweat and Perspiration.** Sweat is the name applied to the liquid which is secreted so fast that it gathers in drops on the surface; perspiration, to the moisture which is continually and unconsciously given off.

**Function of Perspiration and Sweat.** They aid in cooling the body by their evaporation. Water to change into vapor absorbs a large amount of heat; thus the moisture upon the body in passing off into vapor absorbs heat from the body.

**Amount of Perspiration.** This varies from one-half to two pints in twenty-four hours. If this function is interfered with, it causes too great strain upon the kidneys, to which the skin acts as a supplementary organ.

**Sebaceous Glands.** These glands secrete a lubricating fluid or oily matter which keeps the skin soft and pli-

able. They open into the hair follicles, and are most abundant on the head.

**The Hairs.** These are a modified form of the epidermis. They each have a root, springing from a vascular papilla at the bottom of an involution of the epidermis, called a hair follicle. Into the hair follicle open one or more sebaceous glands.

**The Nails.** These are flattened, horny structures of modified epithelium. They cover the tops of the toes and fingers. They are for protection and to aid in picking up articles.

**Sensibility of the Skin.** The sensations received through the skin are obtained through the *sense of touch.* This is subdivided into three divisions. First, *tactile sensibility,* by means of which we recognize the slightest touch and the exact point of contact. Second, the *sense of pressure or weight,* by which we are able to judge of the compression exerted on a given area. Third, the *sense of temperature,* by which we are able to judge whether an object is hot or cold. It is from these divisions of the sense of touch that some authors derive more than the usual five senses.

## NERVOUS SYSTEM.

**Divisions.** There are two divisions of the nervous system, the *cerebro-spinal,* or that presiding over animal life, and the *sympathetic,* that regulating organic life.

**Structure.** It is composed chiefly of two structures: the gray, originating impulses and receiving impressions, and the white, conducting impressions.

**Cerebro-spinal System.** This consists of the *brain, spinal ganglia, cranial nerves,* and *spinal nerves.*

**Membranes Surrounding the Brain.** The membrane which lines the skull constituting an interior periosteum is called the *dura mater*; beneath this is a delicate membrane called the *arachnoid,* and still beneath this is another membrane, which even dips into the convolutions of the underlying brain. This is called the *pia mater.*

**Divisions of the Brain.** The divisions of the brain are the *cerebrum, cerebellum, pons varolii,* and *medulla oblongata.*

**Functions of the Cerebrum.** "The cerebral hemispheres are the organs by which perception is carried on and from which motor impulses are given out. They contain the organ of the will; they possess memory, or the means of retaining impressions of sensible influences; and they are the medium of all the higher emotions and feelings. They carry on intellection as is evidenced by imagination, understanding, reflection, and judgment." (*Hare.*)

**Functions of the Cerebellum.** "It is absolutely insensible to irritation and may be cut away without any signs of pain; its removal from the body or destruction by disease is generally unaccompanied by loss or disorder of sensibility. Animals from which it is removed can see, hear, and feel pain to all appearance as perfectly as before. It governs the coördination of movements, and

while irritation of the cerebellum produces no movements at all, remarkable results are produced by removing part of its substance. As portion after portion of it is cut away the animal gradually loses the power of springing, walking, standing, or preserving its equilibrium. If laid upon its back it cannot recover its normal posture but struggles to get up, and if a blow is threatened tries to avoid it, but fails to do so. According to Gowers, the middle lobe of the cerebellum governs equilibrium by means of afferent fibres from the semicircular canals and the ocular muscles and also the muscles of the legs." (*Hare.*)

**Function of the Pons Varolii.** "It contains a large number of nerve fibres both transverse and longitudinal, and is a conductor of impressions from one part of the spinal axis to another. Concerning its functions as a nerve centre little or nothing is certainly known."

(*Hare.*)

**Spinal Cord.** This occupies the cavity of the backbone. It extends from the brain down to the last vertebra. It is protected by the same membranes as the brain, but in the brain the gray matter is on the outside, while in the spinal cord the gray matter is within. It is divided into halves and these again subdivided into two parts. It contains two nerves of motion and two of feeling. The nerves of motion are the ones which carry the orders of the mind to the different organs, while the nerves of feeling bring back impressions which they receive.

## *THE CRANIAL NERVES.*

PLATE XC. 1, 2, Cerebrum; 3, Cerebellum; 4, Medulla Oblongata; 5, Spinal Cord; 6, First Spiral Nerve; 7, Second Spiral Nerve.

9. **Olfactory**, or the first pair of nerves. This is the nerve of special sense by which odors are distinguished; in other words, it is the nerve of smell. It is distributed to the mucous membrane of the nose.

10. **Optic Nerve** is the nerve of sight and is distributed to the retina of the eye. It conveys no other impulses than those of sight.

11, 12, 13. **Oculo-motor** nerves are three pairs of nerves used to move the eyes. One pair seems to be devoted to the governing of the accommodation of the eye.

14. **Trifacial** or fifth pair of nerves divide each into three parts. The first of which supplies the upper part of the face, eyes, and nose; the second division supplies the lower lid, the cheeks, nose, upper lip, and teeth of the upper jaw; the third supplies the muscles of mastication, teeth in the lower jaw, and the tongue where it forms the sense of taste.

15. **Facial** or seventh pair of nerves are distributed over the face to give it expression.

16. **Auditory** or eighth pair of nerves go to the ears and to the nerves of hearing.

17. **Glosso-pharyngeal** or ninth pair of nerves are distributed over the mucous membrane of the pharynx and passes to the root of the tongue, the tonsils, the soft palate, and the tympanum.

18. **Pneumogastric** or tenth pair of nerves preside over the larynx, lungs, liver, stomach, with one branch extending to the heart.

19. **Spinal Accessory** or eleventh pair of nerves, rise from the spinal cord. They regulate the vocal movements of the larynx.

20. **Hypoglossal** or twelfth pair of nerves give motion to the tongue, influences mastication, and articulate language.

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## *THE VOICE AND SPEECH.*

NOTE.—In nearly all air-breathing vertebrates there is some arrangement for the production of sound in some part of the respiratory apparatus. Various modifications of this sound are produced in some animals, while in man its modifications are so great as to permit speech.

**Larynx.** The voice-organ, formed of cartilages united by ligaments at the upper end of the wind-pipe, is called the *larynx.* The lower part of the larynx is bounded on each side by thin membranous bands, which, extending from side to side, vibrate as the air rushes over them. This part of larynx is called the glottis. The sound is produced by the forcing of air outward over the bands or cords. The larynx acts simply as a cavity in which the vocal cords are situated. These are governed by the muscles of the larynx. Within this small space there are nine muscles which are so arranged as to stretch or relax the vocal cords.

**How the Voice or Sound is Produced.** Within the glottis are false and true vocal cords. The false are two folds of mucous membrane, one on each side. These

false cords do not produce sound, although they indirectly influence vocalization. The true cords are two strong, yellow elastic, fibrous tissue bands. These cords produce sound by their vibrations, caused by the expiratory air being forced through the glottis.

**Protection to the Glottis.** At the base of the tongue, in front of the upper opening of larynx, is a leaf-shaped cartilage called the *epiglottis*, which shuts like a lid over the opening during the act of swallowing. This prevents the food or liquid from entering the passage to the lungs. Should this be opened by breathing while the food is passing, portions will enter the larynx and cause violent coughing.

**Differences in Sound.** The vocal cords are capable of making differences in sound. Those distinguished by the ear are loudness, pitch, and quality. Only a few different sounds are made by the vocal cords. These sounds are modified by the lips, tongue, teeth, and palate.

**Male and Female Voices.** Including all forms of voice, the musical range extends over about three and one-half octaves; but a single individual can rarely sing more than two octaves. The lowest note of the female voice is about an octave higher than the lowest note of the male voice. The highest note of the female voice is about an octave higher than the highest note of the male.

**Whispering.** When sound is not accompanied by the action of the vocal cords there is only a whisper.

**Effect of Epiglottis on Sound.** When the epiglottis is pressed down so as to cover the cavity of the larynx, the sounds are rendered deeper in tone and fuller in quality.

## THE SENSE OF TASTE.

In the mucous membrane of the tongue, soft palate, and the upper portion of the pharynx, are found the endings of the nerves of taste. The chief sense of taste is situated in the tongue. This organ has two nerve supplies; the back part, capable of recognizing bitter substances, is supplied by the *glosso-pharyngeal* nerve, while the tips of the tongue, recognizing sweets, is supplied by the lingual branch of the tri-facial nerve.

**Aid to the Sense of Taste.** The sense of smell aids very much in the distinction of articles. If the nose be held close and the eyes are bandaged, no difference can be determined between a piece of apple, potato, or onion on the tongue.

There are no nerves of taste in the lips.

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## THE SENSE OF SMELL.

**Position.** The sense of smell is found in the mucous membrane lining the upper portions of the nasal fossæ, where the *olfactory nerves* are distributed.

**How Excited.** The sense of smell is excited by fine bodies floating in the atmosphere. The extreme delicacy of smell can best be understood when we remember "Valentin has estimated that two-millionths of a milligram of musk is sufficient to excite the olfactory nerves of man."

## HEARING.

**The Ear.** In man the organ of hearing is divided into three parts, of which two, the *external ear,* and the *middle ear,* are used to carry the waves of sound to the third or *internal ear,* which is designed to receive the vibrations.

The organ of hearing, like the organ of sight, is double; but, by reason of the position of the ears, it is possible to lose the power of hearing in one ear, and retain that of the other. It is a common case to see an eye which is injured affect, by sympathy, the other eye. The reason for this is that the two ears do not communicate with each other, while the eyes do. Although there is no communication one with the other, we hear but one sound, because of the impression the sounds make on those parts which have a point of union in the brain. The two impressions mingle and become one. When there are several sounds carried to the ear, we have the power of selecting the one we wish to hear clearly and partially, excluding the other. We close our ear, as it were, when there are people on each side of us talking, and we hear only one distinctly.

The organ of hearing is always in action, even when we sleep; while the other senses slumber, the ear alone is on the watch to guard us.

**Divisions and Subdivisions.**

*External ear,* comprising the . . . . . . { Auricle, or pinna,<br>External auditory canal.

| | |
|---|---|
| *Middle ear*, or *tympanum*, comprising . . . . | Membrana tympani,<br>Cavity of tympanum,<br>Mastoid cells,<br>Eustachian tubes. |
| *Internal ear*, or labyrinth, comprising . . | Vestibule,<br>Semicircular canals,<br>Cochlea,<br>Auditory nerve. |

**External Ear.** The external ear is the only portion of the organ of hearing which can be seen, and is placed on either side of the head. In many animals the *auricle* or *pinna*, is certainly used to collect the waves of sound, and its movements serve to determine the direction from which the sounds come. Authorities differ as to its use in man; some claim it is simply a rudimentary structure, others, that it does collect sound, and the larger it is the more capable it is of hearing, because it is a common practice to place the hand behind the ear, in order to hear better. This fact, however, seems to be determined that the folds of the pinna in some way helps to direct or gather the waves of sound, because if the folds are covered with grease or wax, the ability to hear is greatly diminished.

The *external auditory canal* commences at the concha of the pinna, and extends to the membrana tympani. The skin of this canal contains in its thickness a large number of glands which secrete a thick, greasy, yellow, bitter substance called *cerumen* (wax). The bitterness and consistency of the wax serve to prevent insects from entering the minor portion, and it being soft and adhe-

sive, serves to catch other foreign bodies which might otherwise enter. The lining of this canal also contains hair follicles. The hairs growing in this canal are stiff, and aid the wax in preventing the introduction of foreign substances.

**The Middle Ear.** The *middle ear* or *tympanum* consists of a cavity, which is filled with air, and which communicates with the pharnyx by the Eustachian tube. It is separated from the external ear by the *membrana tympani*, and from the internal ear by a bony partition perforated by two windows a round, and an oval one, which are closed by thin membranes. In this cavity are three bones, *malleus or hammer, incus or anvil,* and *stapes or stirrup,* which form a movable chain, passing between the membrana tympani, and oval window. The malleus is attached to the tympanic membrane, while the stapes is in contact with the oval window.

**Tympanic Membrane.** This is commonly called the *drum of the ear.* It receives the vibrations of the air in the auditory canal, transmitttng them to the bones of the middle ear. It is sloped from the outward inward, so that it may more readily respond to sounds of varying character, and be of greater dimensions. It is of a pearl-gray color, and consists of two layers of membrane, between which is found the handle of the malleus.

**Bones of the Middle Ear.** The bones of the middle ear receive their names from their shape. They are so small that they weigh only a few grains, yet these tiny bones are covered with a periosteum. They are connected by perfectly developed joints, which have cartilages, ligaments, and synovial membranes.

**Muscles of the Tympanum.** To the bones in the middle ear are attached muscles which tend to regulate the force of the vibrations carried to the inner ear. To the stapes is fastened a muscle which pulls that bone away from the membrane covering the oval window, whenever a loud sound might jam the bone into the membrane, and produce deafness. To the malleus two muscles are attached; one, by drawing the handle of the malleus inward, changes the tension of *drum of the ear*, preventing it from vibrating too much to sounds of great intensity; the other, by drawing the handle outward, enables us to hear distinctly sounds which would otherwise be scarcely audible.

**Eustachian Tube.** This tube is back of the *membrane tympani* and opens from the middle ear to the pharnyx. It affords vent by which, when the drum is driven in, some of the air may escape. It equalizes the pressure within and without. When near an exploding blast, cannonading, or any other sound of great intensity, the pressure on the ear may be much relieved by opening the mouth.

**Mastoid Cells.** Communicating with the cavity of the middle ear are a number of cells lined with a mucous membrane and filled with air. They serve the part of a sounding-board to the organ of hearing, reinforcing the sound. They are in their rudimentary condition in youth, but develop excessively in old age, thus supplementing by the power of reinforcement the diminuition of sensitiveness, which the different organs of hearing experience in old age.

**Internal Ear.** This part of the ear has been named the *labyrinth*, because it has so many turns in its con-

struction. In the labyrinth is found a system of tubes, communicating with each other, inclosing a transparent liquid in which the terminal cells of the auditory nerve are distributed.

**Vestibule.** The vestibule consists of two superposed sacs, which have no direct communication with each other, but with one of which the *utricle* communicates three semicircular canals. The *utricle* contains in its meshes crystals of calcium carbonate bound together by delicate tissue, which form the *etoliths* or *egg-stones*.

**Semicircular Canals.** These are three curved bony tubes, each describing the greater part of a circle. They are filled with a liquid called *endolymph*. This liquid is in direct contact with the membrane at the oval window, and when the vibrations of the stapes are transmitted to this membrane it is taken up by the liquid and communicated to the auditory nerve.

**Auditory Nerve.** This nerve ends in cells, having minute hair-like processes upon them, and it is believed that these are set vibrating by the vibrations of the endolymph.

**Cochlea.** This cavity strongly resembles the snail shell, from which it derives its name. The cochlea by its spiral turns allows the enclosure in a small space of many nerve filaments, but their function is not clearly understood.

**How we Hear.** Sound is produced by vibrations in the air. When we speak the vocal chords are set in vibration. These are communicated to the air, which carries these vibrations to the membrane tympani, then they go over the chain of bones, through the oval window, into the endolymph, then to the cells of the audi-

tory nerve, at which point the nerve takes up the impression, carries it to the brain, where it is interpreted by the mind.

**The Limits of Auditory Perception.** "Sound can only be perceived when the vibrations which produce it are repeated a certain number of times in a given period; thus physicists have stated that our sense of hearing ceases to appreciate sound from the moment that the elastic body when vibrating produces in a second of time less than 32 simple oscillations for the low sounds, and more than 73,700 for acute sounds. Beyond this limit sensation becomes continuous, and it is impossible to distinguish one sound from another; they make the same impression on the ear that a red-hot coal at the end of a string whirled rapidly round produces on the eye; a circle of light only is seen. Even when the vibrations reach the number of 4500 to 5000, the sounds produce on the ear a painful effect; thus, in an orchestra the high *D* of the piccolo corresponds to 4752 vibrations. The lowest note is the low *E* of the double bass, which corresponds to 41 vibrations.

We have said that 32 simple vibrations constitute the limit of perceptible sounds; but this limit varies according to the individual. Some people have naturally less developed acuteness of hearing, and cannot even distinguish the song of a cricket on the hearth. Among musical instruments the pipes of the organ alone are able to give out sound corresponding to 32 oscillations in the second, but this sound is so faint that it can only be compared to a breath or whisper."

**Care of the Ear.** 1. Cold water should not be allowed to enter the ear.

2. It is best to place cotton in the ears when bathing.

3. Never use sharp or hard instruments to remove wax. Use warm water and wipe the ear dry.

4. Use oil to kill insects in the ear. Then warm water to remove insect and oil.

5. Do not "box" a child on the ear, as it may rupture the membrane tympani.

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## *THE EYE.*

**Shape.** The eye is a specially arranged organ, spherical in shape, in which ends the *optic nerve,* or nerve of sight [Fig. LXXVIII. No. 31.] This nerve ends in a portion of the eye called the retina [Fig. LXXVIII. Nos. 19 and 27], which receives images gathered from objects and reflected upon it by means of various parts of the eye. How these parts are arranged so as to reflect the pictures of objects upon the retina so that the nerve of sight, here spread out, may take cognizance, and carry the impression to the brain, will be explained hereafter. This nerve is impressible only by light. The eye must gather the images and focus them upon the retina. Should the retina be exposed to the light with no media for refracting before it, there could be seen no objects, and the only effect would be the perception of light from darkness.

**Position.** The eye is lodged in a deep socket of the bones of the head [Fig. XI. Nos. 6 and 7]. It is held in position by these bones, aided by the ocular muscles [Fig. LXXVII Nos. 7 to 12 inclusive], the optic nerve [Fig. LXXVIII. No. 31], and the eyelids.

**Protection.** The eye is protected from blows coming from the front, by the bones of the socket in which it is placed. Besides these, it is protected by a cushion of fat being arranged behind and around the eyeball, which would lessen the force should the eye be accidentally struck. In the front it is protected by the eyelids, which act as curtains, and distribute moisture over the eyeballs constantly, thus preventing drying; by the eyebrow preventing the perspiration running down from the forehead, upon the eyelids; and by the eyelashes preventing the entrance of foreign bodies, especially when the lids are half closed. The eyelashes differ from ordinary hair growths in that they possess tactile sensibility, which causes, reflexly, the lids to close tightly when a foreign body touches them.

**Lachrymal or Tear Gland.** Removing the outer section [Fig. LIV.] which represents the natural open eye, an examination can be made of the eye as it would appear with the eyelids removed and the various parts exposed [Fig. LV.]. In the upper and outer angle of the eye, is a gland called the *lachrymal* or *tear gland* [No. 11] which secretes from the blood a watery fluid, which constantly flows out upon the eyeball to lubricate and keep it moist. By the act of winking the moisture is continually spread over the eyeball. After it has flowed over the eyeball it collects in a little hollow on the inner side, and escapes through the *puncta lachrymalia* [No. 4.], two small channels, one of which exists in each lid, into the *lachrymal sac* [No. 6], and from this through the nasal duct [No. 7], into the nose. Shedding tears is the overflow of this watery fluid, when

it is secreted in an unusual quantity. The overflow is caused by the little ducts not being able at such times to carry off all of the fluid secreted. The lachrymal gland is excited into unusual activity by disease, such as a cold or inflammation, or by certain conditions of the mind, as madness, great joy, or sorrow.

**Experiment.** The fact that these ducts open into the nose, may be shown by holding closed the nostrils, and trying to force air out through them. The passage being closed, the air will be forced up through the nasal ducts into the lachrymal sacs and may be felt coming out at the inner corners of the eyes. Oftentimes if foreign substances get into the eye, they can be forced out by this process.

**Tunics or Coats of the Eye.** The *sclerotic* [Fig. LXXVII. No. 2] and *cornea* [No. 1], the most external protective tunic.

*Choroid* [Fig. LXVIII. No. 9], *iris* [No. 6], and *ciliary processes* [No. 8], the middle or vascular tunic.

*Retina* [No. 19] the innermost nervous tunic.

**Humors of the Eye.** The humors of the eye consist of the various transparent parts through which the light passes to the retina. These transparent parts are called *refracting media*, because they have the power of refracting or bending the rays of light which pass through them. They are three in number, viz.:

*Aqueous humor* [Fig. LXXVIII. No. 3 and 7], filling the front chamber.

*Crystalline lens* [No. 4], lying immediately behind the pupil.

*Vitreous humor* [No. 24], filling posterior four-fifths of the globe of the eye.

**Contractile Tissues.** The *iris* [No. 6], a perforated curtain suspended behind the cornea in the aqueous humor in front of the crystalline lens. The opening a little to the nasal side of the center is called the *pupil* [No. 5]. This curtain has the power of expanding and contracting, thereby governing the quantity of light admitted.

The ciliary muscle [No. 17], attaches the choroid to the sclerotic coat, and by its contractile power governs the diameter and shape of the crystalline lens.

**Sclerotic Tunic.** The sclerotic coat [Fig. LXXVIII. No. 20], is a firm membrane which covers the posterior five-sixths of the globe. It has a smooth white external surface, with an inner one brown stained. It is not continuous over the front sixth of the eyeball, for at this portion is a window-like opening, known as the cornea [No. 2], through which the rays of light pass.

**Cornea.** The cornea is a transparent membrane, having numerous nerves which arise from the ciliary nerves and is set in the sclerotic tunic somewhat as a watch crystal in its case. It permits the light to enter the eye in much the same manner as a window-pane lets light into a room. It also effects very markedly refraction of the rays of light.

**Choroid Coat.** The choroid coat [Nos. 9 and 18], is a thin dark-brown vascular membrane lining the posterior five-sixths of the globe, terminating in front at the ciliary ligament. Owing to its black, pigmented tissue cells, transmission of all light from the exterior is prevented,

excepting through the cornea, and reflection from side to side is also prevented. In albinoes and nocturnal animals this coat lacks pigment and its absence prevents good vision in the day-time.

**Ciliary Processes.** Near the edge of the cornea there are sixty to eighty folds, formed by the plaiting and folding of the choroid at its anterior margin. They are highly vascular, and consist of large and small processes. These are called ciliary processes.

**Iris.** Suspended behind the cornea in a watery substance (aqueous humor) is a thin, circular, perforated, contractile curtain, called the *iris* [Fig. LXXVIII. No. 6]. This curtain is in front of the crystalline lens, with a central opening, the pupil [No. 5], which regulates the amount of light entering the eye. It contains two sets of muscular fibers, circular and radiating. The radiating fibers dilate the pupil, the circular fibers contract it.

When an object is near, the rays of light are so near together that they enter through a small opening; when the object is quite distant the pupil dilates, in order to let all the rays in that it can to make the image more distinct.

**Experiment.** The contraction of the iris can be shown by having some pupil close the eyes and after a short time open them in a strong light, and the change in the iris can be readily seen. The same can be shown by placing the eyes of a cat before a strong light, and afterward removing the same.

**Sudden Light.** When a person has been for some time in a position which has caused the iris to open to

admit as much light as possible through the refracting media, and the person suddenly comes in a strong light, pain is felt. This pain is caused by too much light falling on the retina. The circular fibers of the iris will soon contract and less light be admitted, and the pain ceases. A sudden change of this kind should be avoided.

**Retina.** The innermost coat of the eye, extending over the back and terminating by a ragged margin nearly as far forward as the ciliary body, is called the *retina* [Fig. LXXVIII. No. 19]. This is the membrane which receives the impression of light. It is formed by the expansion of the optic nerve, and is a delicate, grayish, transparent nervous membrane.

**Blind Spot.** The point of entrance of the optic nerve into the retina will not receive any impulse when light falls upon it. It is called the blind spot [No. 28]. All parts of the retina are not equally sensitive to color. Each portion receives different colored rays. The red rays are seen by the outside portion.

**Images Inverted.** The retina receives all images upon its surface inverted. The reason why we do not see all objects upside down is because the brain interprets the inverted image for one in the proper position.

**Aqueous Humor.** Between the cornea and the crystalline lens is a chamber filled with a clear alkaline fluid, mostly water. This chamber is divided into two parts, the anterior and posterior, by the iris. It affords a medium in which the iris can move. It also influences the refraction of light.

**Vitreous Humor.** About four-fifths of the entire globe

of the eye consists of a thin, transparent jelly. It is somewhat circular, but is hollowed out in front, for the crystalline lens. It fills out the crystal, keeping it terse, and aids very largely in the refraction of the rays of light transmitted to it through the crystalline lens.

**Crystalline Lens.** Enclosed in a capsule and lodged in a depression of the vitreous humor, is a transparent double convex body, called the *crystalline lens* [Fig. LXXVIII. No. 4]. It acts like a strong magnifying glass. It is the most important refracting portion of the eye, and, aided by other parts of the eye, directs the rays of light so as to fall properly upon the retina. It is situated between the aqueous and the vitreous humors.

**Photographing Images on the Eye.** There is a certain purple substance on the retina which is destroyed by contact with light. It can only be seen by opening the eye in a dark room and flashing a light upon it. Take the eye of an ox and try the experiment. If the operation be quickly and carefully done, the image which fell upon the retina may be made permanent by dipping it quickly in a saturated solution of alum.

**Accommodation.** The normal eye at rest is so adjusted as to need no change in adjustment for objects twenty feet or more distant. The power of the ciliary muscle to change the curvature of the crystalline lens to adjust it for objects at less than twenty feet is called *accommodation.* The eye, when adjusted for an object four feet away, will see a like object two feet distant indistinctly and vice versa. To show this, place two pins in a lath, one at the further end, and the other in the center. By

holding the same so that it is endwise toward the eye, if you look at the pin four feet from you the one two feet away becomes indistinct.

**Eyes of the Savage.** Savages do not often call into use the ciliary muscle, because the eye does not do much work with objects less than twenty feet distant, while we who live in houses, read our books and newspapers, and perform the work of artisans and mechanics, have our eyes adjusted most of the time by the use of the ciliary muscle. Then is it a wonder that the eyes of the civilized nations do not remain in their original normal condition as long as those of the savages?

**Effect of Steady Use.** It is a conceded fact, that a muscle not in a state of rest cannot be held in one position for a long time without injury. The arm cannot long be held extended, nor the head to one side, without pain or loss of power in the muscle called into action to produce the effect. From this learn a lesson. The ciliary muscle is continually in action if you are reading or sewing, so do not keep your eye fastened steadily for a long time upon an object any fixed distance from you, but occasionally look up from the fixed object. The moment you do so the ciliary muscle changes its condition, and even if you immediately return to your fixed object the muscle has somewhat rested.

**Defects of the Eye.** It is not to be wondered at that an absolutely normal eye probably does not exist, when we consider the number of conditions necessary to cause the images to fall properly upon the retina, so that we may have perfect vision. We consider briefly these defects caused by a malformation or loss of power.

**Astigmatism.** An irregularity in the curvature of the cornea or lens, which causes an inability to see lines running at certain angles, is called astigmatism. Frequently the curvature of the cornea is unequal, hence lines running in one direction will not be focused upon the retina the same as those running in some other direction. Some of these lines will be seen distinctly, the others indistinctly This defect may be remedied by properly adjusted glasses.

**Entopic Images.** Should you use the microscope, you may notice small, dark images on the surface of every object examined. These are caused by the presence of some opaque body in the transparent media of the eye itself. They occur in all eyes to a greater or less extent.

**Color-blindness.** Certain areas of the retina, owing to their imperfect development, are unable to perceive those rays of light which normally fall upon them. Since each portion receives different colored rays, it is readily seen that some of the areas being imperfectly developed, the rays falling on that portion would not be recognized. The common forms of color-blindness are for the red, green, and yellow rays.

**Diplopia.** In some people the two eyes vary enough in construction so that each eye receives the impulse of the light wave at a different time, or on not corresponding parts in the two eyes, and the person has double vision.

**Hemianopsia.** This is blindness in one half of the eye, so that of bodies only half is seen. Since the rays of light cross in the eye, the part of the retina which is blind is always opposite the object, which can not be seen. Thus when the eye sees no object to the right of it, it is the left side of the eye which is blind.

**Myopia.** This is commonly known as "short-sightedness." It is a condition of the eye in which objects are focused at a point in front of the retina. This condition is brought about by two causes, either excess in length of the myopic eye, or an abnormal curvature of the cornea, excessive refractive power of the media, or both causes may be operative in conjunction. The vast majority is undoubtedly due to an increased length of the globe, and is called axial myopia. Animals are decidedly "far-sighted," savages less so with a tendency toward a normal eye, while the highly civilized man is rapidly becoming *myopic.* Children as a rule are "far-sighted;" the eye becomes normal, or even "near-sighted," while growing to maturity. Myopia is hereditary as well as acquired, and if the children of myopic parents are not always "near-sighted," the tendency toward such a condition is more certain in them. To show the effect of steady, continuous application of the eye to near objects, notice the following table. Those trades which require steady application at a fixed distance have the greater percentage of myopia. Tscherning found the per cent. of myopia in males of one age, as follows:

| | |
|---|---|
| Day laborers | 2.45 |
| Mechanics | 5.24 |
| Mechanics on near work | 11.66 |
| Artists | 13.33 |
| Book-keepers | 15.76 |
| Professional men | 32.38 |

**Hypermetropia.** This is commonly known as "far-sightedness." It is a condition of the eye in which images are focused at a point behind the retina. This should not be confounded with the state common to old

age, which will be considered later. The causes for this state, like myopia, are twofold, but of opposite conditions. The globe may be shorter in its diameter from the front to the back than the normal average, or the length of the eye may be normal and the refractive power of the media may be less than normal. In old age the lens becomes flatter.

**Presbyopia.** This is the state of the eye common to old age, due to a loss of accommodation. Accommodative power depends upon the contraction of the ciliary muscle, which lessens the tension of the ligament which holds the crystalline lens in suspension in the aqueous humor, which allows the front surface of the lens to advance by its own elastic power. By this increased dimension of the axis of the lens, its refractive power is sufficiently increased to overcome divergence of rays, etc., as heretofore explained. This elastic power of the lens is greatest in youth, and gradually grows less with advancing years, so that the range of accommodation decreases from childhood to about seventy years of age, when it becomes nothing, and the eye is incapable of adjustment for objects nearer than "infinity."

In connection with this lack of accommodation, we find the eye at about the age of fifty-five becoming "far-sighted," caused by the lens becoming flatter.

**Glasses.** By the use of lenses most of the defects spoken of may be remedied. We have two classes of lenses, namely:

1. Those with thin edges and thicker centers, which converge the rays, or bring them to a focus, called convex lenses.

2. Those with thick edges and thinner centres, which scatter the rays, called concave lenses.

The convex lens is used with a "far-sighted" eye, because the eye not bringing the rays to a focus soon enough to fall upon the retina, a lens of sufficient curvature to aid the eye is added, and by means of the refraction of the glass lens, aided by the refractive media of the eye, the image falls in the normal position, and clear vision is obtained.

The concave glass is used in "near-sightedness." Here the image is focused too soon and by means of a glass which diverges the rays from their normal condition, enough so that the refractive media of the eye in overcoming the divergence of the rays, brings the image upon the retina, normal sight is given and the blurred objects are no longer an annoyance.

If glasses are needed, great pains should be taken to have the eyes properly examined by a graduated optician and the glasses properly adjusted. It is no uncommon thing to find that glasses of different curvature are needed for the different eyes. In few people do we find the two eyes having the same power.

**Cautions.** 1. Do not use the eyes with the light coming from the front.

2. Do not read in railroad coaches while in motion.

3. Do not strain the eyes in imperfect light.

4. Rest the eyes when ever you find them getting weary.

5. Do not lie upon the back and read.

6. If reading, occasionally look up from the book or paper.

7. Do not go without glasses if you need them.

8. Use spectacles in preference to nose-glasses.

## *INTOXICANTS AND NARCOTICS.*

**Alcohol** is a transparent fluid lighter than water, having a peculiar odor and a burning taste. It boils at a much lower temperature than water and is therefore very easily evaporated. Its freezing point is so low that alcohol has never been frozen; this property is taken advantage of to use it in thermometers to register great degrees of cold. Alcohol is very inflammable, burning with a hot, smokeless, bluish flame, producing in its combustion carbonic dioxide and watery vapor.

It readily absorbs water from any substance containing it. Owing to this property, it acts as a *poison* to living tissues, coagulating their *protoplasm* as it cogulates the albumen of an egg. This renders it valuable for preserving animal tissues after death. Alcohol is much used in the arts and manufactures, its great use being as a solvent for substances not soluble in water.

**How Produced.** It is produced by the *fermentation* with yeast of matter containing *sugar*, e.g., cane sugar, or a substance capable of transformation into sugar, e.g., *starch*.

**Yeast** is a lowly vegetable organism allied to the fungi. It has the power of breaking up a solution of sugar into alcohol, water, and carbonic acid. From this watery solution the alcohol is distilled off, and pure, or, as it is called, absolute alcohol, is obtained by distilling again with quicklime which retains the water.

Alcohol is the active agent in all intoxicating bever-

ages. It is found in from two to eight per cent. in beer and ale, in wines from ten to twenty per cent. and in spirits up to fifty-five per cent.

**General Effects of Alcohol.** In small doses alcohol can be completely oxidized in the body just as if it were burned in the air, but the amount thus disposable is very small. Small doses increase the power of the stomach for digesting food, but larger doses stop digestion. Alcohol causes great dilatation of all the blood-vessels of the skin so that much heat is lost, and serious cooling of the body may follow.

When habitually indulged in, it causes disease of the stomach, liver, kidneys, brain, lungs, and heart, giving rise to fatty degeneration and formation of fibrous connective tissue. It greatly lessens muscular power, and diminishes or suspends the action of the whole nervous system, beginning with the highest faculties.

The habit of alcohol drinking is very easily induced but most difficult to check.

**Experiments.** 1. Color some water in a glass tube with a few drops of colored fluid, such as ink. Carefully pour on some alcohol to show that it is lighter than water.

2. Mix a gill of alcohol with a gill of water. The combined bulk is less than one-half pint, and heat is produced. This shows porosity of water and the avidity of alcohol for water.

3. Burn a little in a saucer to show the flame, the absence of smoke, etc.

4. Pour a little white of egg into alcohol. It will be at once coagulated, but will re-dissolve if water be

speedily added. This shows that it is the great avidity for the water in the albumen that causes it to coagulate. If the desire for water is sufficiently supplied it does not take any from the albumen and it no longer coagulates.

**Alcohol in the Stomach.** In the general manikin is found the lining membranes of the stomach in a healthy condition. But Plates L., LI., LII., and LIII. indicate how this organ suffers when it is dosed with alcohol. We have already seen the effect of small quantities in increasing the digestive power, but in cases of excessive and constant drinking the stomach becomes inflamed, and what is called "drunkards' dyspepsia" is produced. Should the cause continue to act, the inflammation goes on from bad to worse, in acute cases ending in ulceration of the walls, and hence perhaps causing a rapid death. In chronic cases it induces fatty degeneration of the gland cells, and their destruction by over-growth of connective tissue, ending in slow starvation from inability to digest food.

On each of these plates we have illustrations showing the effect of alcohol on the small intestine. In the last plate can be seen the effect of heavy drinking. The blood-vessels are widely dilated, their contained blood stagnated or coagulated, and with this there is extravasation of blood in the tissues, death of the tissue, and a casting off of the outside layer, and almost total destruction of the entire lining membrane.

**Effect of Alcohol on the Liver.** The liver is a great sufferer from excessive indulgence in alcohol. This we can understand when we remember how all the alcohol

absorbed by the stomach and intestines goes with the blood of the portal vein to the liver.

Two things may happen: the cells of the liver may undergo fatty degeneration, or it may be invaded by fibrous tissue giving rise to the so-called *hob-nail liver.* In the latter case, as the fibrous tissue contracts we get destruction of the liver cells, destruction of the blood-vessels and bile ducts, and consequent *dropsy* and *jaundice* with increased *dyspepsia.*

Usually it is an incurable condition, and leads slowly but surely to a fatal termination.

This condition of the liver is generally due to excess in spirits. The name "hob-nail" is given on account of the peculiar marking of the surface of the organ.

**The Heart.** Like other important organs the heart is a great sufferer from alcoholism. Habitual drinking causes fatty degeneration and weakening of its action. Diseased conditions while attributable to alcoholism do not always arise directly from that cause. We must remember, however, that many diseases are due indirectly to it, arising especially as the result of chilling the body, and that most if not all diseases are more severe when occurring in habitual alcohol users.

**Effect of Alcohol on the Brain.** Plate LXXVI. shows us the effects of alcohol on the brain. Here at first sight the appearances of disease are trifling: thickening of the blood-vessels, and hardening of the brain tissue. Very different, however, are the effects on the functions of this, the most important organ. The profound changes in the action of the brain are due to three causes: First, we have the direct poisonous action of

alcohol on the brain cells, which are the most important part of the nervous system. Secondly, there is impaired supply of blood owing to arterial disease ; and thirdly, the supporting fibrous meshwork becomes so thickened that the delicate nerve-cells are destroyed, or their connections interfered with.

The whole faculties are gradually degraded till the power of will and the ability to work are lost, and the moral nature utterly ruined. We need merely mention *delirium tremens*, and the fact that alcoholism is one of the greatest causes of insanity in its most incurable forms.

The effects of large amounts taken at one time are unfortunately too familiar to need description here. They are, for the most part, due to direct poisoning of the nerve-cells by the alcohol.

**Effect of Alcohol on the Kidneys.** Excess in alcohol causes conditions similar to those which obtain in the liver, but less marked, viz., fatty degeneration of the kidney cells and fibrous tissue formation. Much oftener, however, these are due to inflammation, the alcohol acting indirectly in predisposing to it. Very grave results may follow, death resulting from poisoning by matters which should have been excreted by the kidney, but have been allowed to accumulate in the body.

**Effect of Alcohol on the Eye.** Plate LXVII. shows the eye inflamed by the use of alcohol.

## *SUMMARY OF THE EFFECTS OF ALCOHOL ON THE VARIOUS ORGANS FROM DR. PARKES' "PRACTICAL HYGIENE."*

**On the Stomach.** In very small quantities it appears to aid digestion; in larger amount checks it, reddens the mucous membranes, and produces the "chronic catarrhal condition," viz., increase of the connective tissue between the glands, fatty and cystic degeneration of the contents of the glands, and finally more or less atrophy and disappearance of these parts.

Taken habitually in large quantities it lessens appetite.

**On the Liver.** Taken in large quantities, it causes either enlargement of the organ by producing albuminoid and fatty deposit, or increase of connective tissue, and finally, contraction.

**On the Spleen.** Its action is not known.

**On the Lungs.** It is said to lessen the amount of carbonic acid in the air of expiration. In large quantities, habitually taken, it also alters the molecular constitution of the lungs, as chronic bronchitis, etc., are certainly more common in those who take much alcohol.

**On the Heart and Blood-vessels.** Alcohol, in healthy persons, at first increases the force and quickness of the heart's action. In a healthy man, Dr. Parkes found that brandy augmented the rapidity of the pulse thirteen per cent. and the force was also increased. The period

of rest of the heart was shortened, and its nutrition must, therefore, have been interfered with. Alcohol causes evident dilatation of the superficial vessels, as shown by the redness and flushing of the skin. It seems likely, therefore, that there must be danger in the use of alcohol when the arteries become rigid in advancing life, if the heart is then susceptible to the action of alcohol.

**On the Blood.** The amount of fat is either increased, or it is more visible. The chemical changes in the blood are partially arrested.

**On the Nervous System.** In most persons it lessens the rapidity of impressions, the power of thought, and the perfection of the senses. In other cases it seems to cause increased rapidity of thought, and excites imagination, but even here the power of control over a train of thought is lessened. In no case does it appear to increase accuracy of sight, nor is their any good evidence that it quickens hearing, taste, smell, or touch.

There can be little doubt that alcohol enters into temporary combination with the nervous structure; and the evidence from the impairment of special sense and muscular power implies that it interferes with the movements of the nervous currents.

**On the Muscular System.** Voluntary muscular power seems to be lessened, and this is most marked when a large amount of alcohol is taken at once; the finer combined movements are less perfectly made. In very large doses it paralyzes either the respiratory muscles, or the nerves supplying them, and death sometimes occurs from impairment to respiration.

**On the Eliminating Organs.** There is a large increase in the insensible cutaneous perspiration, and enlargement of the vessels of the skin.

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## TOBACCO.

Like most plants which have active properties, tobacco contains an *alkaloid* (a substance having chemical properties like the alkalies, *e.g.*, soda), examples of which group of bodies are to be met with in quinine, strychnine, etc. The alkaloid in tobacco is called *nicotine*. Unlike the two others which we have mentioned, nicotine is an uncrystallizable oily liquid which has a strong odor of the plant from which it is extracted. It is intensely *poisonous*, causing death by paralyzing the nerve centres.

In non-fatal doses it causes great sickness, prostration, and failure of the heart, symptoms which are well seen when tobacco is used for the first time in smoking.

When tobacco is smoked, nicotine, with other products of combustion, pass with the smoke into the system. In a pipe some nicotine is condensed in the stem and does not get inhaled; in cigars and cigarettes, on the other hand, all is inhaled. The smoke from these latter, therefore, is more saturated with nicotine and the products of its decomposition, and produces a darker stain when blown through a handkerchief.

In favor of cigar smoking, however, as against the pipe, we have the fact that in a cigar most of the nico-

tine is changed into much less active substances than itself, and hence the harm is not so great.

Over-indulgence in smoking causes irritation of the throat, and dyspeptic symptoms; while a still more formidable result is a serious impairment of vision.

On the whole, tobacco must be looked on as a pure luxury, and one which does more harm than good.

Plate LXVI. shows the effect of cigarette smoking on the larynx.

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## ANTISEPTICS, DISINFECTANTS, AND DEODORIZERS.

**Antiseptics.** In cases of wounds it is often the case to find that poisonous germs existing in the air are absorbed, and the wound does not heal properly because of the germs producing putrefaction in the injured tissue. Blood-poisoning may follow the absorption of these microscopic organisms. Certain agents have the power of destroying these poisonous germs, and are known as *antiseptics.*

**Deadly Poisons.** Some of the most valuable antiseptics are among the deadliest poisons, even in very small quantities. They should never be used except under the direction of a physician. People who are wounded should insist on antiseptics being used. If the attending physician refuses or neglects his duty in this respect, choose another. Among the antiseptics *corrosive-sublimate* is the most valuable known. It occurs in the form of small, white granules, and is very poisonous. It

is used by dissolving *three grains* in a pint of hot water. A small quantity of glycerine placed upon the corrosive-sublimate, before adding the hot water, will hasten the solution. This solution is used in washing and cleaning the wound. Carbolic acid, salicylic acid, blue vitriol, idoform, sugar, and alum are all among the antiseptics.

**Disinfectants** are agents which have the power of destroying or neutralizing infectious matter which is the product arising from those suffering from a contagious disease, as small-pox, scarlet fever, measles, and a variety of other sources, as sewers, cesspools, decaying matter, etc. Disinfectants are used in solid forms or in solution to destroy the infectious germs contained in the clothing or cesspools, and often found in the apartments of the sick.

**Fumigation** is disinfection by means of a gas instead of by the use of solids or solutions. This is very valuable in disinfecting air, and articles which would be destroyed by wetting.

**Precautions Against Contagious Diseases.** While disinfection will destroy the germs left behind by a disease, yet it is well to observe all precautions possible to prevent contagion. Should a pupil be taken ill of a contagious disease in a school-room or in a family, the room should be fumigated before those who have not been exposed to the contagion should be allowed to enter. The patient should be removed to the top of the house, or to a distant part of the dwelling. Before doing this, remove from the room to be occupied by the patient everything not needed for the comfort of the sick. No one should be allowed to enter the room except the one

caring for the patient, and that person should communicate with the family as little as possible. All clothing and bed linen should be disinfected before removing from the room. Even the dishes should receive proper attention. The attendant should never eat or drink anything that has been standing in the room. As the patient recovers, several warm sponge baths should be given, with an antiseptic solution consisting of three grains of corrosive-sublimate to a quart of water, before leaving the room. Clothing that has not been kept in the room should be placed upon the patient immediately preceding departure.

Dead bodies should be wrapped in linen saturated in a solution of corrosive-sublimate of fifteen grains to a pint of water, or a solution of six teaspoonfuls of carbolic acid to a pint of water. The corrosive-sublimate has not a disagreeable odor, while carbolic acid is more or less unpleasant.

**A Few Disinfectants.** In the sick room fresh air and cleanliness are always at hand. Besides these we have

*Brimstone* (Roll Sulphur) for fumigation.

*Copperas* (Sulphate of Iron), one and one-half pounds to a gallon of water is used in cesspools and sewers.

*Common Salt* and *Sulphate of Zinc*, four ounces of each to a gallon of water, is valuable to disinfect clothing and bed linen.

*Corrosive-sublimate*, sixteen grains to a quart of water, is used to receive discharges from the body, when the patient has cholera, typhoid fever, etc. The quantity used should equal the amount of discharge. This is

very poisonous, and must be used with the greatest caution.

**How to Use Disinfectants.** All clothing, towels and bed linen, before removing from the room, should be placed in a tub of boiling *salt and zinc solution.* All discharges should be received in vessels which contain either the corrosive-sublimate or the copperas solution.

**Prevention of Diphtheria.** Every person in contact with a person afflicted with diphtheria should use disinfectant gargles as a preventive. A physician should prepare the gargle and give directions for its use.

**How to Fumigate.** Every opening, such as doors, ventilators and chimneys, should be tightly closed. All blankets, bedding and other articles which cannot be treated to the zinc solution should be hung on lines in the room. All colored articles should be thoroughly dry, because if moist the fumes will destroy some of the colors. Mattresses and upholstered furniture should be taken apart. The hair or other filling should be treated to the zinc solution, while the other parts should be exposed.

Take a wash-tub or barrel and place in it bricks on which to set an iron kettle. Pour water in the tub or barrel till it nearly covers the bricks. Place in the iron kettle which sets upon the bricks roll-sulphur and set it on fire by means of hot coals, or with the aid of a little alcohol poured over it and then ignited. About three pounds of sulphur should be used to every thousand cubic feet. Keep the room closed at least twenty-four hours, after which thoroughly air.

**Cesspool Disinfection.** To every five hundred pounds

of the estimated contents use one pound of corrosive-sublimate in solution. Sprinkle *chloride of lime* daily over the contents during epidemics, and at least every two weeks at other times.

**Deodorizers** are agents which destroy or neutralize the offensive odors arising from decaying matter or in the sick room. They may or may not have the power of destroying contagious matter, their use being simply to mask unpleasant odors. Those that have disinfectant properties as well as deodorizing are carbolic acid, chloride of lime and chloride of zinc. The simple deodorizers are burning cotton, paper, or coffee. A portion of chloride of lime placed on a plate on the mantel is a very good constant deodorizer,

**How to Use Deodorants.** Chloride of zinc, an ounce to a quart of water, sprayed about the room occasionally is an effectual means of destroying offensive odors.

**Chloride of Lime** used as above suggested.

Use the disinfectants as suggested for discharges from the body. Burn paper, cotton or coffee, and let the smoke pass in the room.

**Chlorine.** This is a very powerful disinfectant. It is a green gas and attacks chemically nearly all contagious matter. It is used in the form of gas, which is generated and allowed to pass into the rooms. If this is generated in cellars where vegetables and other articles mold it will destroy the fungus. It is very penetrating, and has bleaching properties. Articles that would be injured by this gas should be removed and disinfected by other means. Consult any standard work on chemistry as to the generating of chlorine gas.

## TEMPORARY RELIEF TO THE INJURED.

Accidents are of daily occurrence, and we should be ready and qualified to give the injured temporary relief. Do not, however, usurp the functions of physician or surgeon, but study to give proper relief till one can be obtained. Remember "a little learning is a dangerous thing," so be careful not to interfere with the immediate procuring of a proper medical attendant.

**Broken Arms or Legs.** If it is necessary to move the person who is suspected of having a broken leg or arm, great precaution should be taken to prevent what is at first only a simple fracture becoming a compound one. Splints should be bound to both sides of the limb before moving. Fence boards, broom handles, umbrellas, canes may be used as temporary splints. Do not move the injured till something is done to keep the injured limb from bending. Keep the patient quiet till the surgeon arrives.

**Dislocations.** These are sometimes mistaken for broken bones. Unless certain as to the injury, simply keep the patient quiet till proper aid arrives. The reduction of a dislocation generally requires great skill, and should only be performed by surgeons. There are, however, a few exceptions where aid may be given in case a surgeon is not near at hand—notably those of the shoulder, fingers, and jaw.

**Dislocated Shoulder.** When the humerus is out of its place, it may be placed in the proper position by placing in the arm-pit several handkerchiefs or towels rolled into

a ball; the attendant then placing his heel (boot removed) against the ball of cloth, and grasping the patient's hand, pulls downward. If the foot be turned outward and the arm of the patient brought toward the chest during the pulling, the bone will generally slide very easily back into position. After the bones are back into position the arm should be bandaged to the chest.

**Lower Jaw.** As a result of gaping, laughing, or straining, the lower jaw is occasionally dislocated. To reduce, place the person in a chair and stand facing; then place a thumb upon each side of the lower jaw at the back near the last molar, and press the chin upwards with the fingers. As this is done, the thumbs should be pressed downward and backward. It is best to cover the thumbs by wrapping cloths around them to prevent their being injured when the jaws suddenly close.

**Burns and Scalds.** These are of different degrees, and if the burn or scald is serious temporary relief only should be attempted and a physician immediately called.

Remedies which soothe and protect the parts against air and cold are the ones to be used. Some of these can be easily obtained, as common baking-soda (*bicarbonate of soda*), flour, starch, magnesia and powdered charcoal. One of these should be thickly dusted over the burned surface. Castor oil, linseed oil, vaseline, mucilage, or molasses may be advantageously used.

**Catching Fire.** Many persons lose their lives yearly from the catching fire of some part of the clothing. A person in this condition should be immediately thrown upon the floor or ground to prevent the flames from rising about the head and face, so that there is no

danger of the flames being swallowed. Next roll the person on the ground or floor to extinguish the flames, at the same time cover with a blanket, coat, rug, or any other material that is at hand. Water must be freely used to extinguish the fire effectually.

**Scalds** should be treated the same as burns.

**Frost Bites** are caused by exposure of the body to a very low temperature. Still air and snow are favorable to the injured. When the wind is blowing, the warm air near the body is rapidly changed for cold air and the danger is increased. Snow is a bad conductor of heat and is of advantage as a protector. A person having some portion of the body frozen should not be taken to a warm room. Sudden changes in temperature is usually fatal. The person should be so treated that the temperature will rise gradually. The patient should be placed in a cool room, the clothing removed from the frozen part, and the part bathed in cold water or rubbed with snow. After the frozen part loses its hardness or rigidity rub with the naked hand or flannel. Continuous rubbing may be soon abandoned and occasional rubbing take its place. Be careful not to be harsh, as the frozen flesh if roughly handled may have the skin destroyed. Nourishment in the form of beef-tea or milk may be given as soon as the patient is able to take it.

**Fainting.** This is caused by a sudden failure of the heart to perform its full action. But very little blood goes to the brain and unconsciousness follows. It may be caused by fear, grief, joy, pain, tight lacing, exhaustion, hot and vitiated atmosphere, etc. It is usually

attended with a pale face, and cold feet and hands. Usually the duration of unconsciousness is short, but sometimes lasts for hours, during which time the pulse is weak or lost and the respirations oftentimes are not discernible. Fainting occurs frequently, but is not usually fatal.

The heart and circulation should be stimulated, and the amount of blood in the brain increased. To do this the patient should be placed in fresh air, in a position so that the head may be a little lower than the body. All tight clothing should be removed or loosened and the limbs rubbed. Camphor or ammonia may be placed on a cloth and held to the nostrils. No attempts should be made to administer any liquids till the person is well able to swallow.

**Asphyxia.** This is a condition of unconsciousness caused by the oxygen in the blood being diminished. It is caused by drowning, croup, or by breathing $CO_2$, sometimes found in caves, wells and mines. Illuminating gas and "choke damp" from mines are frequent causes of suffocation. Gas from stoves is a frequent cause of death. Drafts are closed and the gas formed within the stove instead of escaping by means of the chimney passes out into the room. People are found unconscious as a result of the accumulated gas. There are two products from combustion, $CO_2$ (Carbonic-dioxide) from perfect combustion, and $CO$ (Carbonic-monoxide) a resalt of imperfect combustion. The first gas is not poisonous and only shuts out the oxygen causing simple asphyxia, and the patient can be restored to consciousness provided they are able to breathe. If

not able to breathe they may oftentimes be restored by artificial respiration as described under drowning. But if the front drafts of the stove have been closed and not enough oxygen has been supplied for perfect combustion, and CO has produced asphyxia different results may be found. This gas is the blue gas often seen above coal before it has received sufficient oxygen to form it into $CO_2$. It is very penetrating even passing out through the pores of the heated iron of the stove. This gas is a poison and asphyxia by means of this gas is very dangerous, as the person even though oxygen is supplied has the symptoms of poison. A physician should be immediately called.

**Drowning.** "The asphyxia or suffocation that follows submersion is due to the fact that air is prevented from reaching the lungs. More or less water is found in the air-passages, but not in such quantities as is generally supposed. In some cases very little if any water reaches these organs, on account of the rapid closure of the epiglottis. Water, however, enters the stomach, and considerable is found mixed with mucus in the throat. Death is usually the result of suffocation, as is made obvious, after the removal of the body from the water, by the bloated and discolored appearance of the face. However, in some cases death may be due to sudden heart-failure before the person sinks. When such is the case the face of the drowned would be pale and flabby, and very little water and mucus would be found in the respiratory tract. There is a better chance of resuscitating one who sinks as the result of syncope than when suffo-

cated, as the demand for oxygen in the former is less than when asphyxiated by submersion.

"Persons who are submerged for four or five minutes or more are not usually restored to life; although numerous cases are recorded where resuscitation was effected after an interval of twenty minutes. In such cases it is supposed that syncope occurred, or, on account of the existing excitement, an error was made in calculating the actual time of submersion. The action of the heart usually continues some little time after respiration ceases.

"*Treatment.* The treatment consists first in re-establishing respiration, then stimulating the action of the heart and circulation by the use of stimulants and warmth, friction, etc. When a person has been under water but a few moments, simple means may restore respiration, and should be first tried.

"The water, sand, and mucus should first be quickly removed from the mouth and nose, and the attendant should then carry his finger to the back or base of the patient's tongue, which must be pulled forward, thus enabling the water and mucus in the throat and respiratory tract to escape, and also to favor the entrance of air into the lungs; while this is being done the patient should be turned on his side (left, if possible), face downward, to favor the escape of water from the stomach and air passages. He should then again be turned on his back, while the hands of the attendant are placed on the belly or abdomen and pressure directed upward and inward toward the diaphragm. This movement tends to stimulate respiration and should be repeated two or three times at intervals of two or three seconds. The

mouth in the mean time should be kept open by a cork or piece of wood, or a knot tied in a handkerchief, etc., in order that the passage of air to the lungs should not be interfered with. Smelling-salts, ammonia, or two or three drops of nitrite of amyl, may be administered by inhalation, or the nose may be tickled with a feather or straw. When breathing commences and consciousness returns, the patient should be carefully divested of all wet clothing (if necessary, the clothing should be cut in order to avoid delay), well rubbed, and wrapped in warm covering.

"If the simple measures just enumerated are productive of no good result after a short trial, artificial respiration should be at once resorted to.

"Of the various methods of artificial respiration Sylvester's method is very efficient, having the advantage of being capable of manipulation by one person.

"Before artificial respiration is begun, the patient should be stripped to the waist, and the clothing around the latter part should be loosened so that the necessary manipulations of the chest may not be interfered with.

"*Sylvester's Method.* The water and mucus are supposed to have been removed from the interior of the body by the means above described. The patient is to be placed on his back, with a roll made of a coat or a shawl under the shoulders; the tongue should then be drawn forward and retained by a handkerchief which is placed across the extended organ and carried under the chin, then crossed and tied at the back of the neck. An elastic band or small rubber tube or a suspender may be substituted for the same purpose. If no other means can

be made available, a hat- or scarf-pin may be thrust vertically through the end of the tongue without injury to this organ. The attendant should kneel at the head and grasp the elbows of the patient and draw them upward until the hands are carried above the head and kept in this position until one, two, three, can be slowly counted. This movement elevates the ribs, expands the chest, and creates a vacuum in the lungs into which the air rushes, or, in other words, the movement produces *inspiration.* The elbows are then slowly carried downward, placed by the side, and pressed inward against the chest, thereby diminishing the size of the latter and producing *expiration.* These movements should be repeated about fifteen times during each minute for at least two hours, provided no signs of animation present themselves." (*Doty.*)

# EXPLANATORY INDEX

TO THE

# STANDARD MANIKIN.

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PLATE I.—BONES OF THE SKULL.

1. Frontal.
2. Ethmoid.
3. Lachrymal.
4. Malar.
5. Parietal.
6. Temporal.
7. Sphenoid.
8. Superior maxillary.
9. Inferior "

PLATE II.—BONES OF TRUNK.

10. Fifth Cervical.
11. Sixth Cervical.
12. Seventh Cervical.
13 Sternum.
14. Clavicle.
15. First true rib.
16. Second " "
17. Third " "
18. Fourth " "
19. Fifth " "
20. Sixth " "
21. Seventh" "
22. First false rib.
23. Second " "
24. Third " "
25. First floating rib.
26. Second " "
27. Tenth dorsal.
28. Eleventh "
29. Twelfth "
30. First lumbar.
31. Second "
32. Third "
33. Fourth "
34. Fifth lumbar.
35. Ring of cartilage.

36, 37, 38, 39. Sacrum.

40. Coccyx.
44. Ossa innominata.

PLATES III. AND IV.—BONES OF UPPER EXTREMITY.

41. Humerus.
42. Radius.
43. Ulna.

PLATES V. AND VI.—BONES OF THE HAND.

45. Pisiform.
46. Cuneiform.
47. Semilunar.
48. Scaphoid.
51. Trapezoid.

52. Trapezium.
53. Metacarpus.
54. First row phalanges.

PLATE VII. AND VIII.—BONES OF THE LEG.

57. Head of Femur.
58. Femur.
59. Patella.
60. Tibia.
61. Fibula.

PLATE IX. AND X.—BONES OF THE FOOT

62. Astragalus.
63. Os calcis.
64. Scaphoid.
65. Internal cuneiform.
66. Middle "
67. External "
68. Cuboid.
69. Metatarsal.
70. First row phalanges.
71. Second row phalanges.
72. Third " "

PLATE XI. — BONES OF THE HEAD, SIDE VIEW.

1. Frontal.
2. Parietal.
3. Occipital.
4. Temporal—squamous portion.
5. Sphenoid.
6. Temporal—petrous portion.
7. Lachrymal.
8. Ethmoid.
10. Nasal.
11. Superior maxillary.
12. Inferior "
13. Atlas or first cervical.
14. Axis or second cervical.
15. Third cervical
16. Fourth "
17. Fifth "
18. Sixth "
19. Seventh "
20. Os hyoid.
49. Vuciform.
50. Os magnum.
55. Second row phalanges.
56. Third " "

PLATE XII.—MUSCLES OF THE HEAD.

1 and 2. Occipiti frontalis.
3. Temporal fascia.
4. Attolens aurem.
5. Occipitalis.
6. Attrahens aurem.
7. Retrahens aurem.
8. Sterno cleido mastoid.
9. Trapezius.
10. Zygomatic attachments
11. Masseter.
12. Orbicularis palpebrarum.
13. Ciliaris.
14. Pyramidalis nasi.
15. Compressor nasi.
16. Levator labii superioris alæque nasi.
17. Depressor alæ nasi.
18. Depressor septi.
19. Levator labii superioris.
20. Levator anguli oris.

21. Zygomatic minor.
22. " major.
22. Risorius.
24. Orbicularis oris.
25. Levator labii inferioris.
26. Depressor labii inferioris.
27. Depressor anguli oris.
28 Platysma myoides.
29. Trachea.
30. Cartilage.

PLATE XIII.—INTERNAL MUSCLES OF TRUNK.

1. Platysma nyoides.
2. Sterno-cleido mastoid.
3. Trachea.
4. Thyroid gland.
23. Subclavius.
24, 25. 26, 27. Third, Fourth, Fifth, and Sixth ribs.
28. Intercostal muscles.
29. Pectoralis minor.
30. Coracoid process.
31. Subclavian artery.
44. Abdominis oblique.
45. Serratus anticus major.

PLATE XIV.—EXTERNAL MUSCLES OF TRUNK.

5. Scalemus anticus.
6. Trapezius.
7. Clavicle.
8. Pectoralis major.
9. Deltoid.
10 Latissimus dorsi.
22. Rect. abdominus.
46. Sartorius.
47. Tensor fascia latæ.

PLATE XV.—INTERNAL MUSCLES OF ARM.

32. Coraco-brachialis.
33. Biceps.
34. Pectoralis major.
35. Deltoid.
36. Compression over artery formed by knot.
37. Rod used in tightening the compression.
38. Supinator longus.
39. Insertion of biceps.
40. Radialis internus.
41. Supinator longus.
42. Palmaris longus.

PLATE XVI.—EXTERNAL MUSCLES OF ARM.

11. Biceps.
12. Tendon of biceps.
13. Triceps.

PLATES XVII. AND XVIII.

48. Palmaris brevis.
49. Pollicis brevis.
50. M. Lumbric I.
51. M. Lumbric II.
52. M. Lumbric III.
53. M. Lumbric IV.

PLATE XXI.—VIEW OF INTERIOR OF BODY.

5. Vena cava.
17. Thoracic duct.
19. Ascending vena cava.
20. Abdominal aorta.
21. Kidney.
22. Renal vein.
29. Bladder.

PLATE XXII.—VIEW OF INTERIOR OF BODY.

23. Renal vein.
25. Kidney.
26. Ureter.
27. Iliac artery.
28. Iliac vein.

PLATE XXIII.—THE ARM.

7, 8. Brachial vein.
9. Brachial artery.

PLATE XXIV.—IDEAL VIEW OF CIRCULATION OF ARM.

PLATE XXV.—VENOUS CIRCULATION OF HAND.

PLATE XXVI.—IDEAL VIEW OF CIRCULATION.

PLATE XXVII.—VENOUS CIRCULATION OF LEG.

1. Femoral vein.
5. Patella.

PLATE XXVIII.—IDEAL VIEW OF CIRCULATION OF LEG.

1. Femoral artery.
2. Femoral vein.
3 Femur.
4. Patella.
5. Patella fibial artery post.
6. Fibial artery anterior.
7. Fibula.
8. Tibia.

PLATE XXIX.—THE HEAD.

1. Cerebrum.
2. Cerebellum.
3. Medulla oblongata.
4. Spinal cord.
5. Branches of the nerves of taste.
6. Olfactory nerves.
7. Frontal sinus.
8, 9. Concha.
10. Opening of Eustachian tube.
11. Tongue.
12. Soft palate.
13. Epiglotis.
14. Trachea.

PLATE XXX.—THE HEAD.

1. Cerebrums.
2. Cerebellum.
3. Pons Varolii.
5, 6. Optic nerve.
7. Globe of eye.
8. Nerve of taste.
9. Nerve supply to upper teeth.
10. Facial nerve.
11. Nerve supply to lower teeth.
12. Spinal cord.
13. Lower maxillary.

PLATE XXXI.—EXTERIOR VIEW OF THORAX.

1, 2. Sternum.
3, 4. Clavicle.
5. Rib.
6. Articulation of rib.
7. Pleura.
8. Outline of head.
9, 10. Outline of liver.
11, 12. Outline of stomach.

PLATE XXXII.—INTERIOR VIEW OF THORAX.

1. Right ventricle.
2 Left ventricle.
3. Right auricle.
4. Pulmonary artery.
5. Left auricle.
6. Vena cava.
7. Axillar vein.
8. Jugular vein.
9. Trachea.
10. Jugular vein.
11. Axillar vein.
14, 15, 16. Lobes of the lungs.
17 Bronchial tube.

PLATE XXXIII.—INTESTINES.

1. Tranverse colon.
2. Ascending colon.
3. Jejunum.
4. Bladder.

PLATE XXXIV.—THE DIAPHRAGM.

PLATE XXXV.—EXTERIOR VIEW OF STOMACH.

1. Cardiac opening.
2, 3. Ducts from liver and pancreas.
4. Blood supply of stomach.

PLATE XXXVI.—INTERIOR OF STOMACH.

2. Cardiac opening.
3. Pylorus.
4, 5. Ducts from liver and pancreas.
6. Small intestines.

PLATE XXXVII.—EXTERIOR VIEW OF LIVER.

1. Gall bladder.

PLATE XXXVIII.—INTERIOR VIEW OF LIVER.

1. Gall bladder.
2. Portal vein.

PLATE XXXIX.—SPLEEN AND PANCREAS.

1. Spleenic vein.
2. Spleenic artery.
3. Body of pancreas.

FIG. LIV.

Exterior view of the eye.

FIG. LV.

1. Cornea.
2. Iris.
3. Meibomian glands.
4. Puncta lacrymalia.
5. Lachrymal canals.
6. Lachrymal sac.
7. Nasal duct.
8. Meibomian glands.
9. Margo infraorbitalis.
10. Palpebra superior.
11. Lachrymal gland.
13. Margo supraorbitalis.

FIG. LVI.

1, 2, 3, 4. Muscles of the eye.
6. Cornea.
E to I. Branches of the ciliary artery.

### Fig. LVII.

16. Radiated fibres.
17. Dollinger's ring.
18. Ciliary arteries.
19. Ciliary nerves.

### Fig. LVIII.

10. Retina.
11. Zonules of Zinn.
12. Anterior of radiated border of zonules of Zinn.
13. Anterior wall of canal of Petil.
14. Posterior of border of zonules of Zinn.

### Fig. LIX.

1. Posterior aperture of the sclerotic for the passage of optic nerve.
2. Openings for passage of ciliary nerves and branches of the posterior ciliary arteries.

3, 4. Superior choroidal veins.

5, 6. Inferior choroidal veins.

### Fig. LX.—View of Back of the Eye.

1. Optic nerve.
2. Sclerotic.

3, 4. Muscles attached to sclerotic.

5, 6. Veins from the tissues of the eyes.

7. Optic nerve.

### Plate LXI.—The Ear.

1. Concha.
2. Protective hairs.
3. Cartilaginous portion of external auditory canal.

4, 6. Wax cells.

5. Partotis.
7. Tympanum.
8. Root of zygomatic process.
9. Vaginal process.
10. Styloid process.
11. Glenoid cavity.
12. Glaserian fissure.
14. Zygomatic process.
15. Right temporal bone.

### Fig. LXII.—The Ear.

3. Malleus.
4. Long process of malleus.
5. Manubrium mallei.
6. Long process of incus.
7. Ossiculum orbiculare Syloii.
8. Incus.
9. Short process of incus.
10. Canal, inferior semicircle.
11. Canal, posterior semicircle.
12. Canal, superior semicircle.
13. Vestibule.
14. Stapes.
15. Membrane tympani.
16. Cupula cochlea.
17. Cochlea.

### Fig. LXIII.

| | |
|---|---|
| 19. Crus anterius, 20. Ampulla ossea, superior, . . 21. Crus posterius, | of superior semicircular canal. |

23. Canal, semicircular, posterior and inferior.

| | |
|---|---|
| 22. Crus superius, 24. Crus inferius, . 25. Ampulla ossea, inferior, . . | of posterior semicircular canal. |

26. Fenestra rotunda.
27. Canal, semicircular externus and horizontalis.
28. Crus anterius of horizontal canal.
29. Ampulla ossea anterior.
30. Fenestra ovalis.
31. Promontorium.
32. Inferior curve of cochlea.
34. Third (half) curve of coch lea.
35. Cupula and apex cochlea.

### Fig. LXIV.

37. Scala tympani and inferior.
38. Lamina spiralis.
39. Vestibulum.
40. Canal, superior semicircular.
41. Canal, externus semicircular.
42. Canal, posterior semicircular.

### Fig. LXV.

53. Third winding of lamina spiralis.
54. Canal, superior semicircle.
55. Hamulus laminæ spiralis.
56. Scyphus.
57. Zonula ossea laminæ spiralis.
58. Membrane of 57.
59. First winding of lamina spiralis.
60. Second winding.
61. Sacculus rotundus.
62. Sacculus oblongus.
63. Ampulla.
64. Ampulla anterior membrane.
65. Ampulla inferior membrane.
66. Canalis externus semicircular.
67. Common termination of semicircular canals.
69. Zonula membrane.

### Fig. LXX. — The Tooth, First Right Lower Molar.

1. Section of gum.
2. Section of inferior maxilla.
3, 4, 5. External tubercles or cusps.
6, 7. Grooves in crown in which particles of food lodge.
8. Crown, external surface of enamel.
9, 10, 11. Margin of gum around neck of tooth.
12. Crotch of the roots.
13. Posterior root.
14. Anterior root.

### Fig. LXXI.

1, 3, 5. Portion of external tubercles which change into two internal.
2, 4. Grooves in crown.
6. Enamel.
7. Section of dentine, showing ramifications of dentinal tubes.
8. Pulp nerve.
9. Edge of canal through which the vessels and nerves of pulp pass.
10. Dental vessels and nerves.

### Fig. LXXII. — The Kidneys.

1. Body of kidney.
2. Renal artery.
3. Renal vein.
4. Ureter.

### Fig. LXXIII.

1. Calices majores.
3. Pelvis renalis.
4. Ureter.
5. Hilus renus.
6. Papillæ.
7. Papillæ.
8. Pyramids.
9. Columns Bertini.
10, 11. Substrata.
12. Papillæ.
13, 14. Matphigian pyramids.

### Fig. LXXIV.

1. Renal artery.
2. Renal vein.
3. Ureter.

### Fig. LXXVII. — Side View of Eye.

1. Cornea (*White of the eye*).
2. Tunica sclerotica (*Horny membrane.*
3. Palpebra superior (*Eyelid*).
4. Cilia (*Eyelashes*).
5. Trochlea.
6. Levator palpebra superior.
7. Obliquus superior.
8. Rectus superior.
9. Nervus opticus (*Optic nerve*).
10. Rectus externus, origin by two heads.
11. Rectus internus.
12. Rectus inferior.
13. Obliquus inferior.
14. Rectus externus, lower origin.
15. Rectus exteruns, upper origin.

### Fig. LXXVIII. — Side Section of Eye.

1. Epithelium.
2. Cornea (*White of the eye*).
3. Aqueous humor, front chamber.
4. Crystalline lens.
5. Pupil.
6. Iris.

7. Aqueous humor, rear chamber.
8. Ciliary process.
9. Ora serrata.
10. Body of cillaris.
11. Plica semilunaris.
12. Conjunctiva.
13. Membrana descemetii.
14. Canal of schlemm.
15. Ligamentum pectinatum iridis.
16. Canalis petiti.
17. Zonula Zinnii.
18. Choroid.
19. Retina.
20. Sclerotica.
21. Muscle rectus superior.
22. Facia tenoni.
23. Rectus inferior.
24. Vitreous humor.
25. Facia tenoni.
26. Blind spot.
27. Retina.
28. Lamina cribrosa.
29. Opticus vaginalia.
30. Canal centralis.
31. Optic nerve.

Fig. LXXX. — The Larynx.

1. Os hyoides.
2. Cornu major.
3. Corpus.
4. Cornu minor.
5. Ligthyreo hyoid lateral.
6. Corpuscul tritic.
7. M. sterno-hyoid.
8. M. thyreo-hyoid.
9. Lig. thyreo hyoid med.
10. Incis thyr. sup.
11. Cornu sup.
12. Cartilage thyreoid.
13. Lig. crico-thyreoid.
14. M. crico-thyreoid.
15. Cartilage cricoidea.
16. Lig. crico-tracheale.
17. Cartilage.

Fig. LXXXI.

1. Epiglottis.
2. Opening.
3. Lig. epiglottis.
4. Cartilage Wrisbergii.
5. Cart Sautorinii.
6. M. arytaen transverse.
7. M. arytaen obliqui.
8. M. crico-arytæn. post.
9. Cart. cricoid.
10. Lig. cerato-cricoid.
11. Channel.
12. Cartilage trachea.
13. Cornu inferior.

Plate LXXXII.—(From 1 to 5 same as Plate LXXXI.)

7. Cart. arytaen.
8. Process.
9. Lig. crico-arytaen.
10. Lig. cerato-crico. sup.
11. Lig. cerato-crico. inf.
12. Cricoid cartilage.
13. Channel.

14. Cartilage tracheal.
15. Cornu superior.
16. Cornu inferior.

PLATE LXXXIII. — HEART, WITH PERICARDIUM ROLLED BACK.

1. Vena cava.
2. Aorta.

PLATE LXXXIV. — HEART DIVIDED.

1. Right Ventricle.
2. Aorta.
3. Pulmonary artery.
4. Superior vena-cava.
5. Right auricle.
7. Left auricle.
8. Pulmonary veins.
10. Longitudinal division.